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FINAL REPORT

ORBIT INJECTION ERROR ANALYSIS

SUB CONTRACT 306 to AF19(628)-500

Re Entry Systems Department
General Electric Company
Philadelphia, Pennsylvania

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INTRODUCTION

Task four of the "Separation Sequence Error Analysis" has been completed. The results, presented herein, are based on inputs listed in a September 4, 1964 letter from L. E. Beardslee (GE-RSD) to Donald C. MacLellan (MIT). Any deviation from those inputs will be pointed out in this report.

The parameters of particular interest in an error analysis are those that can be controlled most easily. In this study, e.g. offsets, products of inertia, tip-off errors, and nominal spin rate have been varied to find the relative importance of each on the accuracy of the mission. Since no requirements have been placed on maximum or minimum apogee altitude acquired from the final initial conditions agreed upon, a parametric study has been made showing the relative effect of varying each parameter. Assumptions, which will be discussed, have led to suggested tolerances on the controlled parameter.

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are drawn from the investigation described herein, and are based in part on a somewhat qualitative set of end conditions specifications assumed by the General Electric Company.

1. The nominal spin rate following separation should be no less than 180 RPM
2. Tolerances on center of gravity location should be no more than ½ inch in any direction.
3. Products of inertia should not exceed 1% of the pitch moment of inertia.
4. Tip-off errors up to 3/4 degree do not seriously degredate the flight results.

DISCUSSION OF RESULTS

In the rocket data received from Thiokol, three, thrust-time histories were given for a range of soak temperatures. The three cases have equal total impulses but the time histories differ. One run was made for each temperature considering all tolerances zero, thus isolating the effects of temperature. The apogee altitudes for the three temperatures are:

Temperature (Deg)	Apogee Altitude (NM)
0	12,289
60	12,343
120	12,333

There seems to be no consistant trend in the results for increasing temperature, and the magnitude of the differences will be seen to be small relative to those differences due to tolerances. Other results from the three temperature runs are shown in table #3. For the remainder of the study the 60 degree thrust data (nominal temperature) has been used with tolerances applied to it. Other input data and tolerances not considered variables of the study are shown in table #1.

Throughout the study, apogee altitude has been the parameter used in making all comparisons between cases. Apogee altitude is measurably dependent on the variables being considered and is one of the orbit parameters of primary interest. Other parameters of interest (mean and one sigma after 40 runs) are given in table 3. Definition of cases 0 through 10 are shown in table 2. Discussion of parameters other than apogee altitude is presented in a later section.

It was determined that forty perturbed runs, in most cases, were sufficient to acquire a reasonably stable value of apogee altitude mean and standard deviation. Cases in which the mean apogee altitude didn't settle to a stable value had standard deviation too high to be considered for successful flight tolerances.

The first case considered, Case 0, had zero tolerances on center of gravity offset, products of inertia, and tip off errors, and a spin rate of 180 RPM. The mean apogee altitude and one sigma deviation obtained from this case will be used as "base" results. The standard deviation of any case including values other than zero for the variables under study, should be greater than the "base" standard deviation. The relative magnitudes of these deviations will be a good measure of each parameter's importance and the tolerances to which each should be limited.

Figure 1 shows the history of mean apogee altitude and one sigma deviation as a function of the number of runs. The standard deviation and mean are both quite stable after forty runs in this case. The "base" one sigma value is 265 nautical miles and the mean apogee altitude is 12,325 nautical miles. In order to determine the significance of these "base" values the distribution about the mean value should be investigated. Figure 2 shows the frequency distribution and the accumulative distribution of the 40 runs. The distribution is close to a normal distribution (not noticably skewed) with the mean value falling near the middle of the accumulative number of occurrences. The probability of being either higher or lower than the mean can be considered the same. The usual definition of one sigma tolerances is that the range of values included in the mean $\pm$ 1σ

should include 68% of the runs. It can be seen from the accumulative number of occurrences in figure 2 that the mean $\pm 1\sigma$ includes approximately 27 of the 40 runs made (67.5%). This is a further indication that 40 runs were sufficient to define the mean and sigma values. This close correspondence with a normal distribution suggests that a means of determining the accuracy of the distribution would be to note what percent of the 40 runs falls within the mean $\pm$ one sigma range. If the percent strays far above the normal 68%, it would indicate that the one sigma tolerance is too large and hasn't settled to a steady value yet. The higher the percentage goes , the further away from a meaningful one sigma value we become. A high percentage will not, however, prohibit using those results to some advantage.

Now that "base" values exist, tolerances are applied to the controlled parameters. The initial selection of tolerances was based on engineering judgement of manufacturing tolerances which would not be unreasonably difficult to maintain. Those selected are:

½ inch C.G. offset

1% products of inertia

½ degree tipoff error

All are taken to be three sigma values. The products of inertia are given as percent of pitch and yaw moments of inertia. In addition a 180 RPM spin rate was used. Figure 3 gives a per run history of mean and one sigma values of apogee altitude. After 40 runs, the standard deviation is 302 nautical miles, and the mean apogee altitude is 12,244 nautical miles. The standard deviation, as expected, is larger than the base value and the mean apogee altitude is slightly less than the base value. The mean $\pm$ one sigma contains 65% of the 40 runs.

Although it is not immediately evident, it will be seen as the study progresses that an increase in any of the controlled tolerances, with the exception of tipoff error, tends to decrease the mean apogee altitude. The reason is that increased C.G. offsets, products of inertia and lower nominal spin rates decrease the effective thrust in the desired direction.

The mean and one sigma results of case 1, compared with case 0 are believed to be acceptable. The remaining cases studied will have higher tolerances than Case 1.

Cases 2 and 3 have respective spin rates of 120 and 60 RPM. The other controlled variables remain the same as in case 1. In figure 5, corresponding to case 2, the standard deviation per run history is less stable than either of the first two cases considered. The final value after 40 runs is 379, appreciably higher than base value of 265, and the mean is down to 12,007 N.M. The percentage of the runs following within mean $\pm$ one sigma (figure 6) is still 67.5%. Thus the accuracy of the standard deviation is considered to be realistic but the magnitude is becoming larger than may be desired.

Case 3 (figures 7&8) indicate that a spin rate of 60 RPM is out of the question. The mean $\pm$ one sigma range contains 82.5% of the runs indicating that standard deviation has not yet stabilized. This is obvious also from figure 7. Even though the standard deviation of 2,695 NM is not accurate, the variations in apogee altitude occurring should not be tolerated since much greater accuracy is available with higher spin rates.

Figure 8 indicates that 6 of the 40 runs attained apogee altitudes of less than 5000 nautical miles and of these, 3 were under 3000 nautical miles. It was ascertained that for any combination of C.G. offsets, products of inertia and thrust misalignment, the spin rate of the vehicle during thrusting would increase or decrease depending on the particular combination. This was found to be true for all the cases studied. The initially low spin rate of case 3 combined with a "despin" combination of variables, in some cases forced the spin rate to zero and tumbling resulted. The thrust was then being applied in many directions, at times cancelling itself, and a very low apogee altitude resulted. In case 1, decreased spin rates of the same magnitude as case 3 occurred but because of the initially high rate, the final rates never became low enough to cause tumbling.

Based on C.G. offsets, products of inertia and thrust misalignments, the spin rate would be expected to decrease as many times as it increases. Based on the modified Euler equations used, which include the effects of inertia changes, a majority of the final spin rates are higher than those at thrust initiation.

Cases 4 and 5 have three sigma offsets of 1 and 1.5 inches respectively and a nominal spin rate of 180 RPM. The results of these two cases are shown in figures 9 through 12. The 1 inch C.G. offset limit produced tolerable results but the 1.5 inch tolerances is unacceptable. One of the forty runs in case 5 despun itself completely and tumbled, causing a very low apogee altitude and a drastic jump in the standard deviation. Since the high value of standard deviation after 40 runs (1146 NM) was caused by only one widely differing run,

the possibility existed that the one run used a rare combination of tolerances which wouldn't occur again in many runs. This could result in a one sigma deviation of about 500 NM which was being approached prior to the large jump. To eliminate this possibility, case 10 was run having all the same tolerances as case 5 except for tipoff error (which will be found later tc be quite insignificant). The results (figures 21 & 22) show that in an additional 40 runs, one was very low, similar to the one in case 5. Again the one sigma deviation jumped from about 500, and after the 40 runs was 1406 NM. The mean apogee altitude in both cases was about 11,750 NM.

Cases 6 and 7 have products of inertia of two and three percent respectively. Based on the results (figures 13 through 16) Products of inertia equal to two percent of the pitch moments of inertia are acceptable, while an increase to three percent is not.

Three sigma tolerances on tipoff error were varied in cases 8 and 9. The rest of the controlled variables are still the same as they were in case 1. A ½ degree tipoff tolerance, (case 8) as opposed to ¼ degree in case 1, resulted in a one sigma deviation of 313 NM. A 3/4 degree tolerance(Case 9) increased the one sigma deviation to 328 NM. It is concluded that tipoff error of the magnitude considered, is not as significant a parameter as the others investigated in this study.

Figures 23 through 26 show a comparison of the results in mean and one sigma apogee altitudes for each controlled variable considered.

Based on the results presented above, an initial spin rate of 180 RPM is strongly recommended. In addition, if no limit exists on maximum spin rate allowable, it would be worthwhile investigating the possibility of biasing the thrust vector - C.G. offset -product of inertia combination to assure that the vehicle spin rate always increases rather than decreases during rocket firing. Since the vehicle must be despun at the end of the maneuver, the disadvantages of the biased variables may outweigh the advantages. If this is the case, C.G. offsets and products of inertia should be kept to a minimum. The three sigma values used in case 1 provided dependably good results. If these tolerances cannot be maintained, the effect of increasing either separately is available. The effect of increasing both at the same time is not known and cannot be determined from the cases considered in this study. Tipoff errors affect the standard deviation of apogee altitude but do not noticably affect the mean apogee altitude.

The other orbit parameters studied had the following general results for the eleven cases considered.

Perigee altitude, unlike apogee altitude had only slight variations for the cases considered. The one sigma variation, in all but two cases, was less than one nautical mile. The mean was always, over 1500 nautical miles, except for the same two cases. The two that differed were cases 2 and 3.

The "base" mean semi-major axis was 10,353 nautical miles with a corresponding one sigma deviation of 133 nautical miles. Case 3 had a mean semi-major axis of only 8717 nautical miles and a one sigma deviation of 1357.

All the other cases had mean semi-major axes greater than 10,000 nautical miles.

The eccentricity for the base case was .523 with a standard deviation of .0061. Case 1, the recommended tolerances, had a mean eccentricity of .520 with a standard deviation of .0069. The other cases, with the exception of case 3, has eccentricities above .5.

Orbit inclination, and apogee latitude had very little dependence on the controlled variables. The orbit inclination was 32.3 degrees and the apogee latitude was 32.0 degrees north. Apogee longitude, on the other hand, shows some dependency. The base value was 135 degrees with a one sigma deviation of 1.1 degrees. The other cases had mean longitudes up to 137.5 degrees(148.2 for case 3) and standard deviations up to 5.9 degrees (15 for case 3). Case 1, the recommended tolerances, had a mean longitude of 135.5 and a standard deviation of 1.6 degrees.

The time it takes to reach apogee for base conditions is 220 minutes-just half of the orbit period of 440 minutes. An increase of controlled tolerances decreases the orbit period slightly. The minimum mean period, occurring in case 3, was 343 minutes. All other cases had periods of more than 420 minutes. The time to the ascending node is 46 minutes with tolerances equivalent to those on period and time to apogee.

Using the three-sigma tolerances of case 1, two other cases were run. The first one assumed a nominal one minute coast period between separation and rocket ignition. The coast period was five seconds in cases 0 through 10. The second case assumed an initial elliptical orbit ranging from 100 nautical miles at perigee to 4000 nautical miles at apogee. The orbit is inclined at 37.3 degrees to the equator.

Separation occurred at apogee, located over latitude 32 degrees south, longitude 4 degrees west. The nominal coast time was five seconds. The results of these cases are given in table 3.

Appendix A contains the results of each run for all the cases considered in this study.

Prepared by L. E. Beardslee

L. E. Beardslee, Engineer

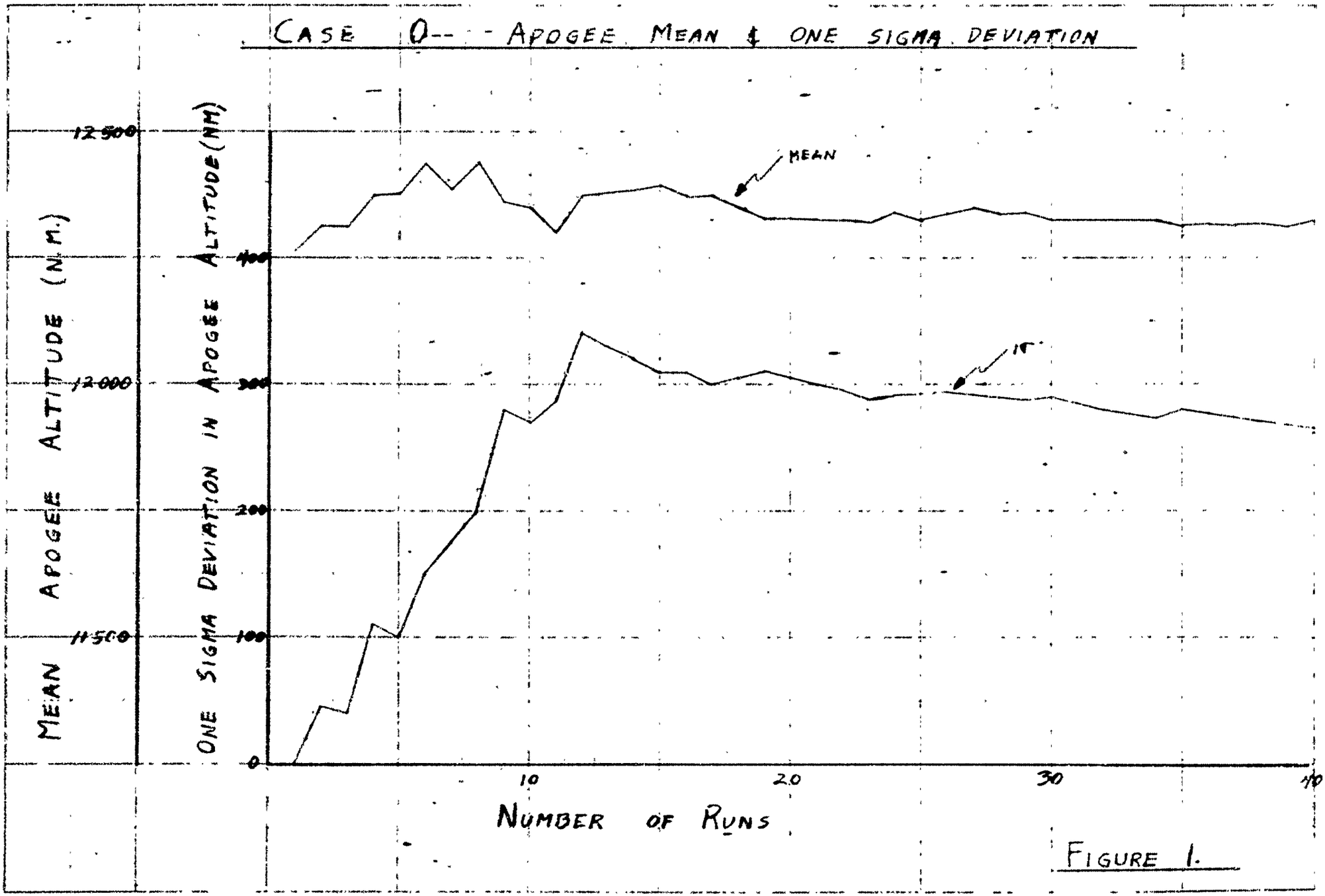
CASE 0 -- APOGEE MEAN & ONE SIGMA DEVIATION
MEAN APOGEE ALTITUDE (N.M.)
ONE SIGMA DEVIATION IN APOGEE ALTITUDE (NM)
12500
12000
11500
100
200
100
0
MEAN
1σ
10
20
30
40
NUMBER OF RUNS

FIGURE 1.

CASE 0 - APOGEE ALTITUDE FREQUENCY DISTRIBUTION

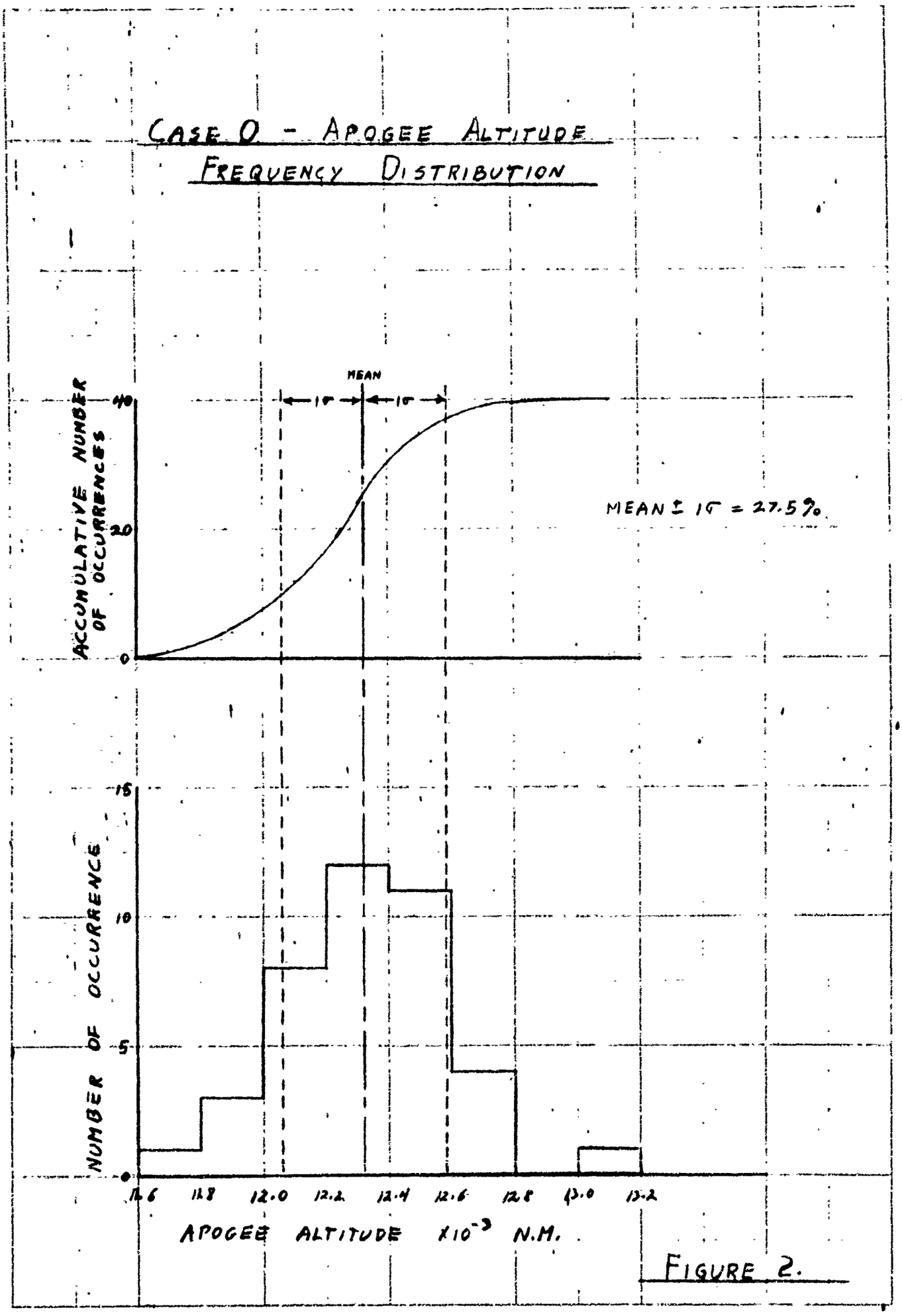

FIGURE 2.

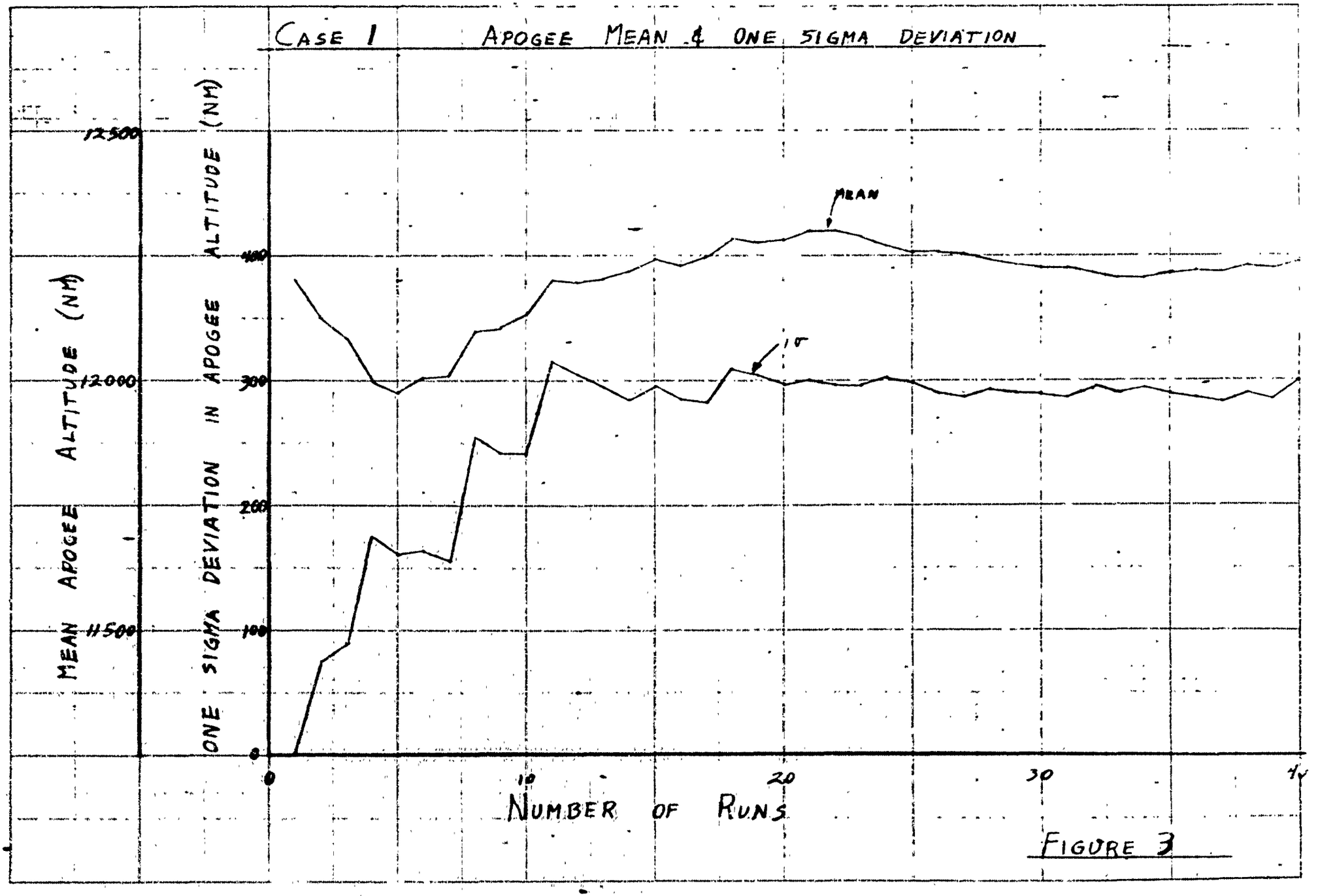
CASE 1
APOGEE MEAN & ONE SIGMA DEVIATION
MEAN APOGEE ALTITUDE (NM)
12500
12000
11500
ONE SIGMA DEVIATION IN APOGEE ALTITUDE (NM)
400
300
200
100
0
MEAN
1σ
0
10
20
30
NUMBER OF RUNS

FIGURE 3

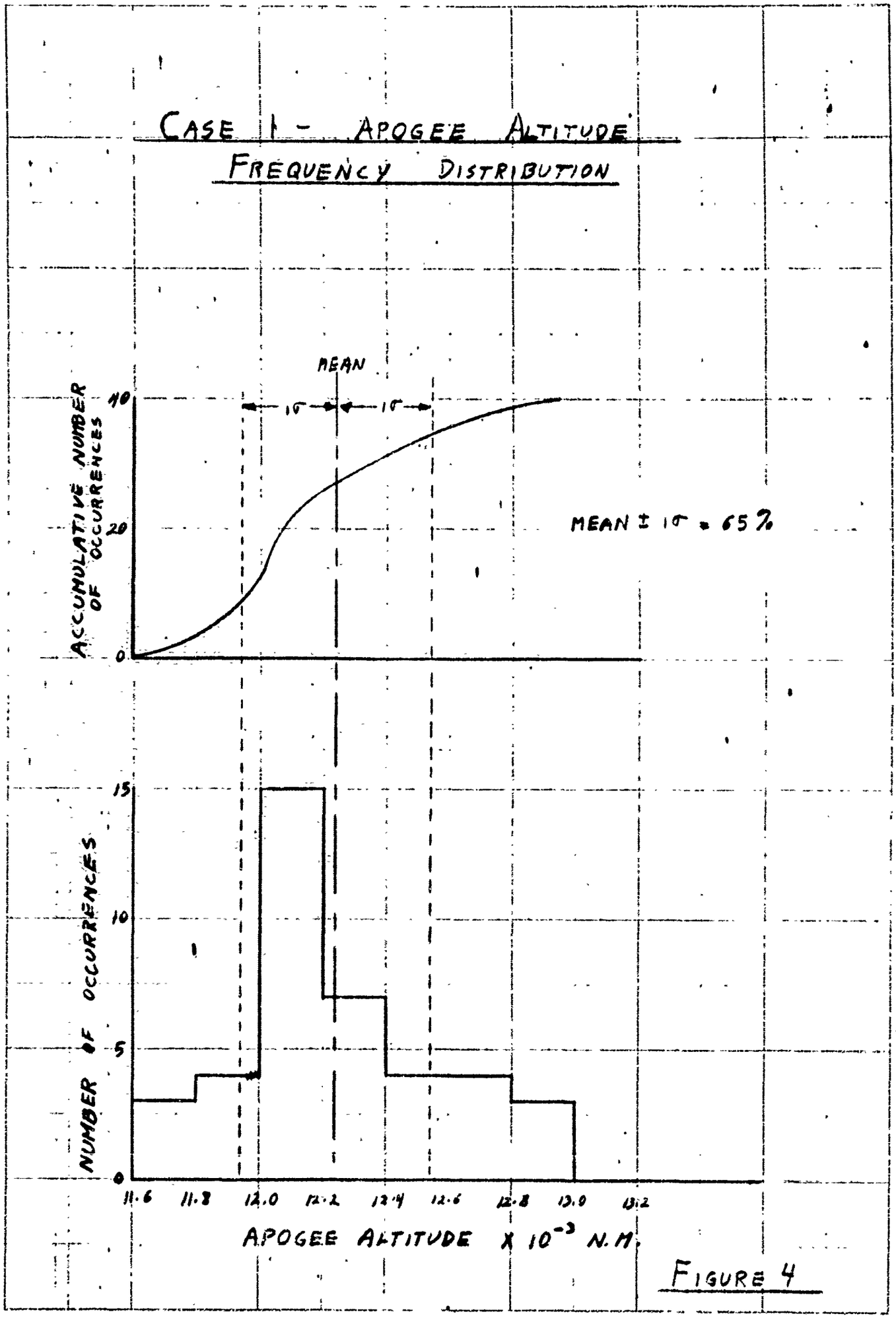
CASE 1 - APOGEE ALTITUDE
FREQUENCY DISTRIBUTION
MEAN
1σ
1σ
ACCUMULATIVE NUMBER OF OCCURRENCES
40
20
0
MEAN ± 1σ = 65%
NUMBER OF OCCURRENCES
15
10
5
0
11.6
11.8
12.0
12.2
12.4
12.6
12.8
13.0
13.2
APOGEE ALTITUDE X 10⁻³ N.M.

FIGURE 4

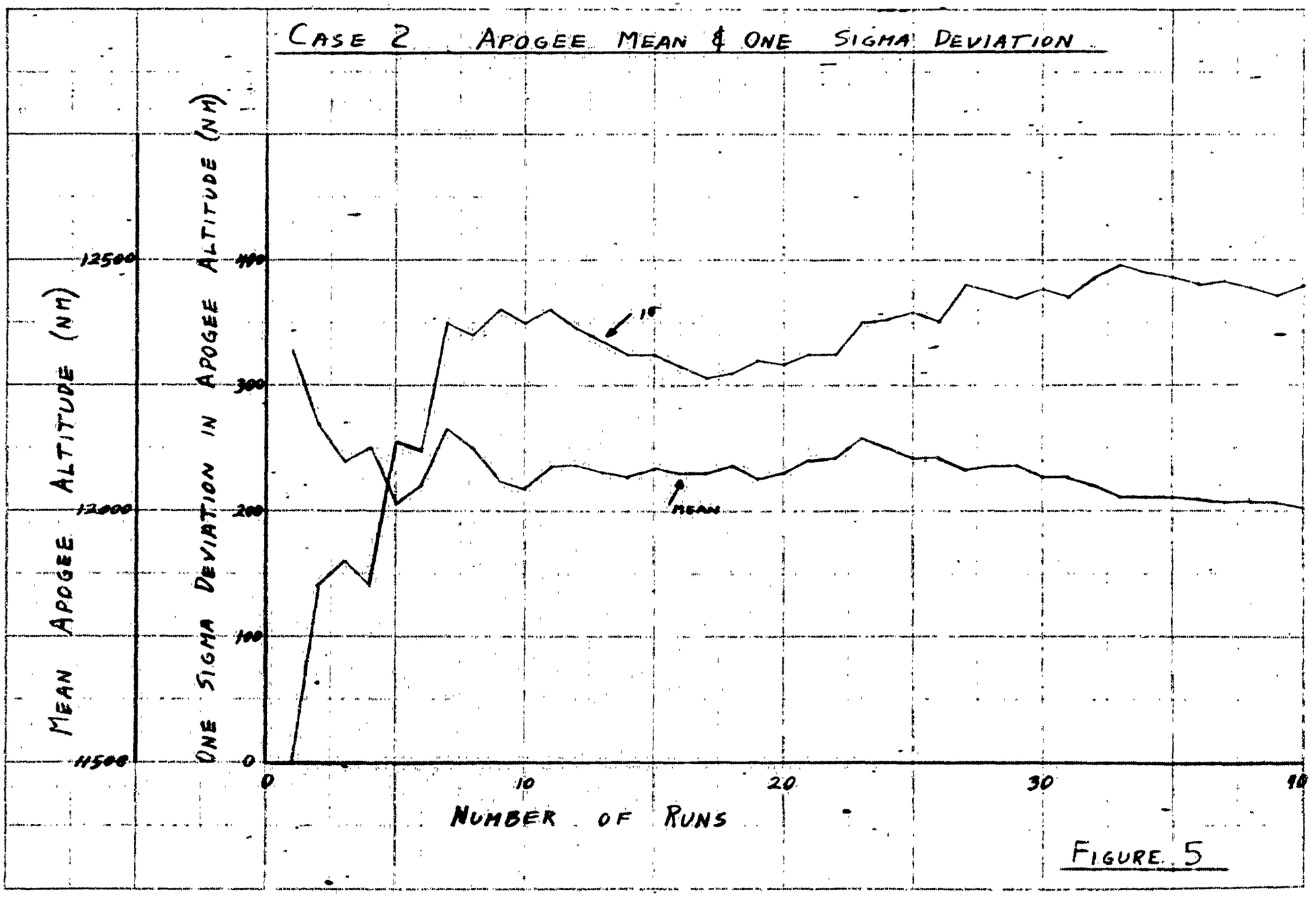
CASE 2 APOGEE MEAN & ONE SIGMA DEVIATION
MEAN APOGEE ALTITUDE (NM)
12500
12000
11500
ONE SIGMA DEVIATION IN APOGEE ALTITUDE (NM)
400
300
200
100
0
1σ
MEAN
0
10
20
30
40
NUMBER OF RUNS

FIGURE 5

CASE 2 – APOGEE ALTITUDE FREQUENCY DISTRIBUTION

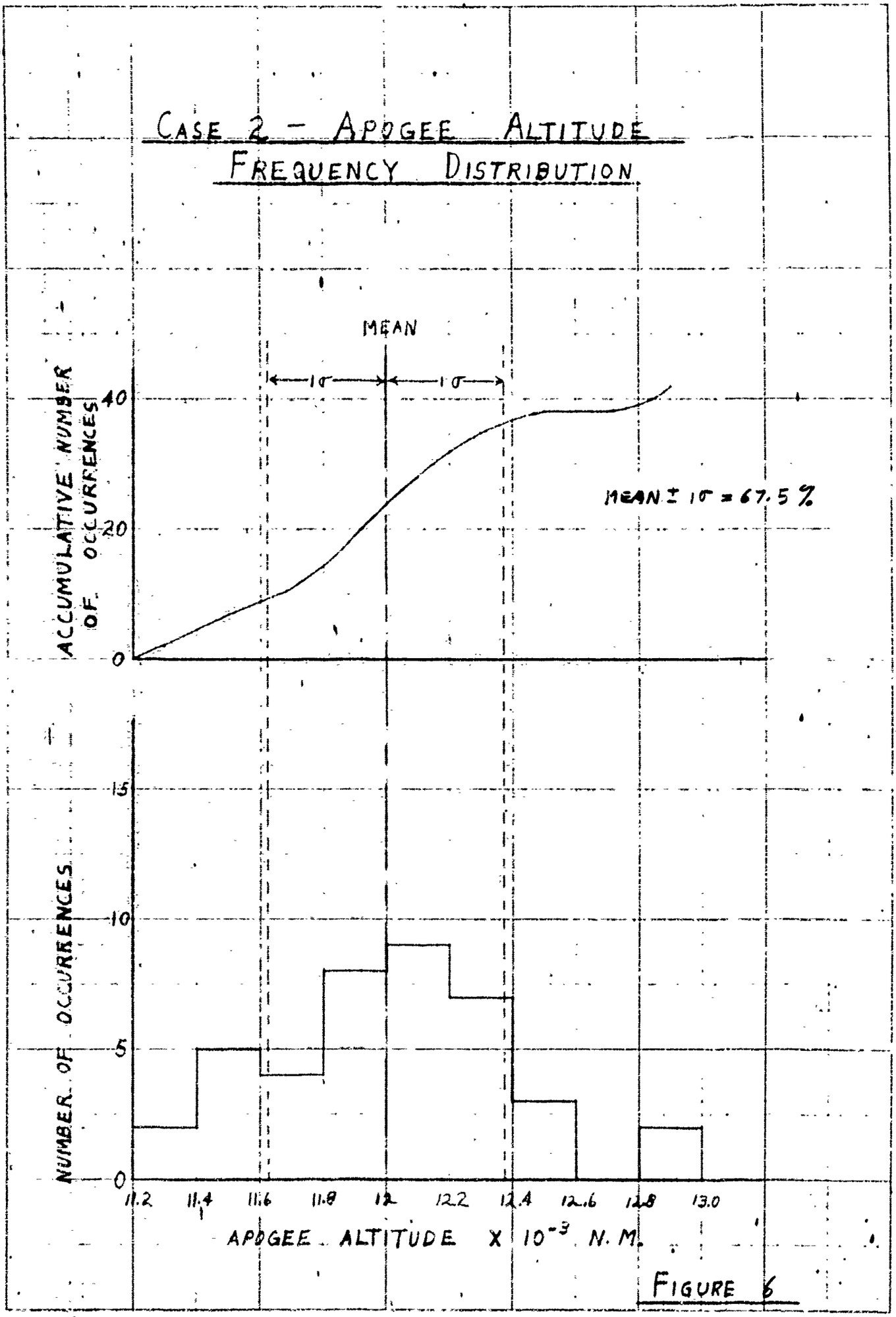

FIGURE 6

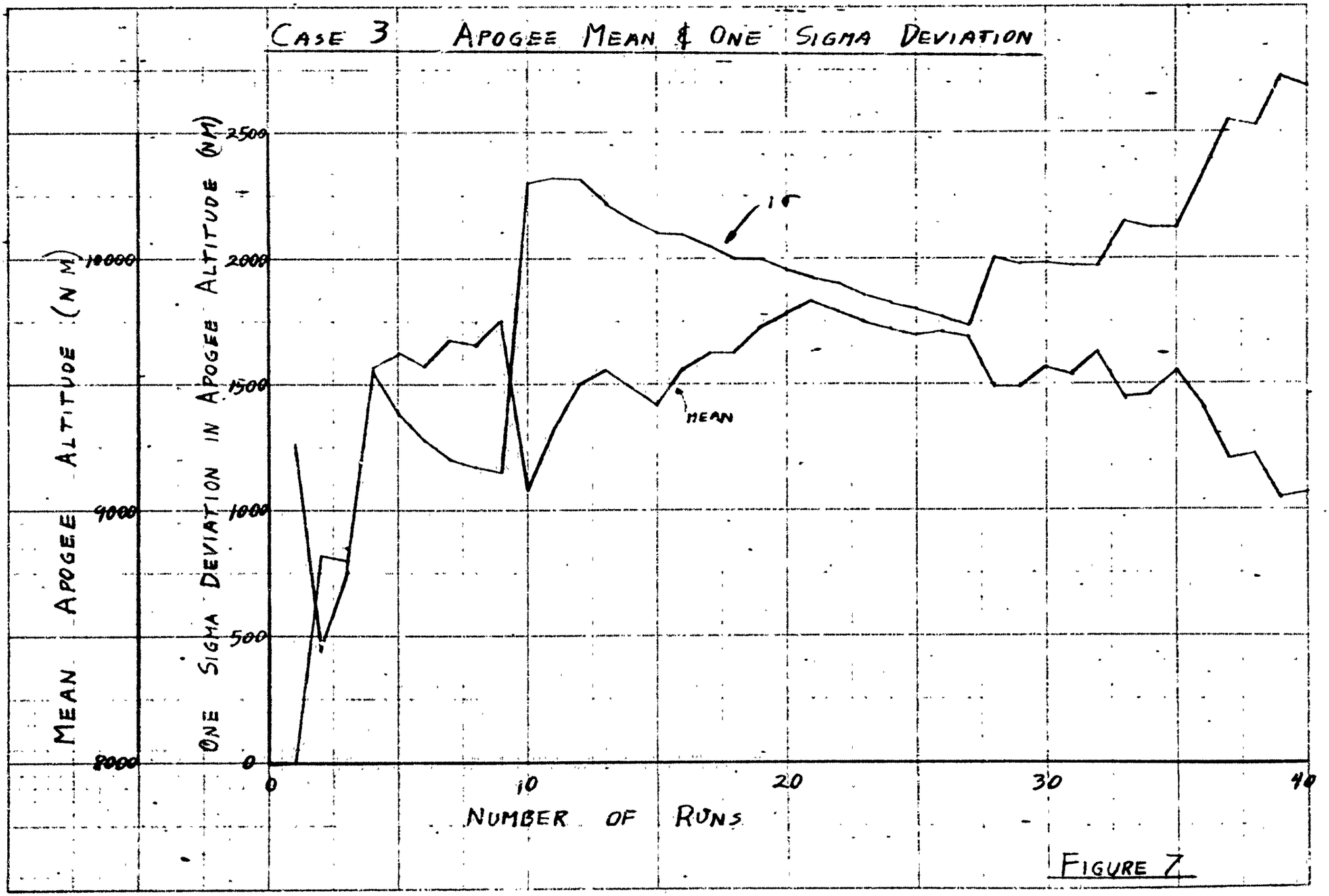
CASE 3 APOGEE MEAN & ONE SIGMA DEVIATION
MEAN APOGEE ALTITUDE (N M)
ONE SIGMA DEVIATION IN APOGEE ALTITUDE (NM)
10000
9000
8000
2500
2000
1500
1000
500
0
1σ
MEAN
0
10
20
30
40
NUMBER OF RUNS

FIGURE 7

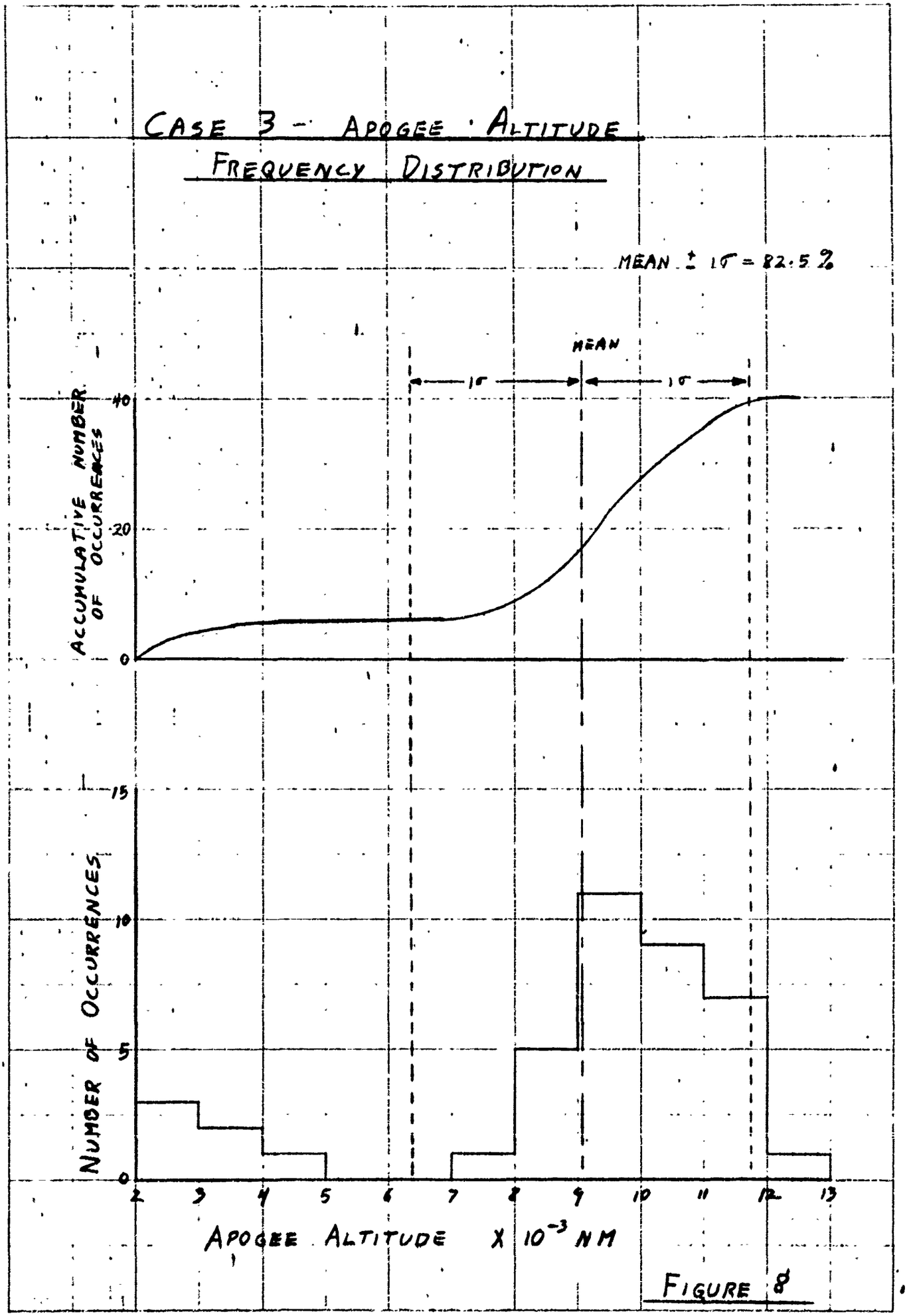
CASE 3 - APOGEE ALTITUDE FREQUENCY DISTRIBUTION
MEAN ± 1σ = 82.5 %
MEAN
1σ
1σ
ACCUMULATIVE NUMBER OF OCCURRENCES
0
20
40
NUMBER OF OCCURRENCES
0
5
10
15
2
3
4
5
6
7
8
9
10
11
12
13
APOGEE ALTITUDE X 10⁻³ NM

FIGURE 8

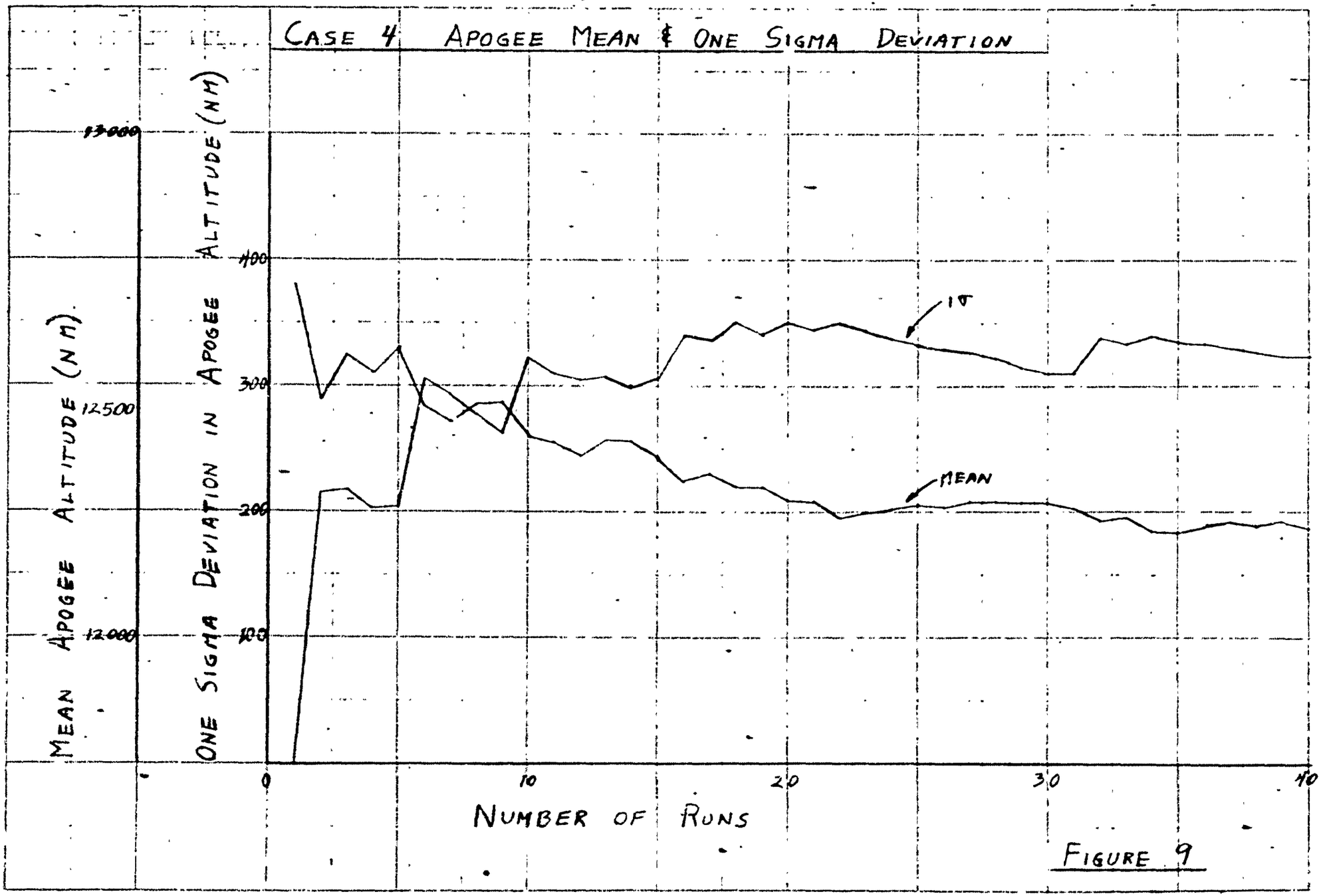
CASE 4 APOGEE MEAN & ONE SIGMA DEVIATION
MEAN APOGEE ALTITUDE (NM)
ONE SIGMA DEVIATION IN APOGEE ALTITUDE (NM)
13000
12500
12000
400
300
200
100
1σ
MEAN
0
10
20
30
40
NUMBER OF RUNS

FIGURE 9

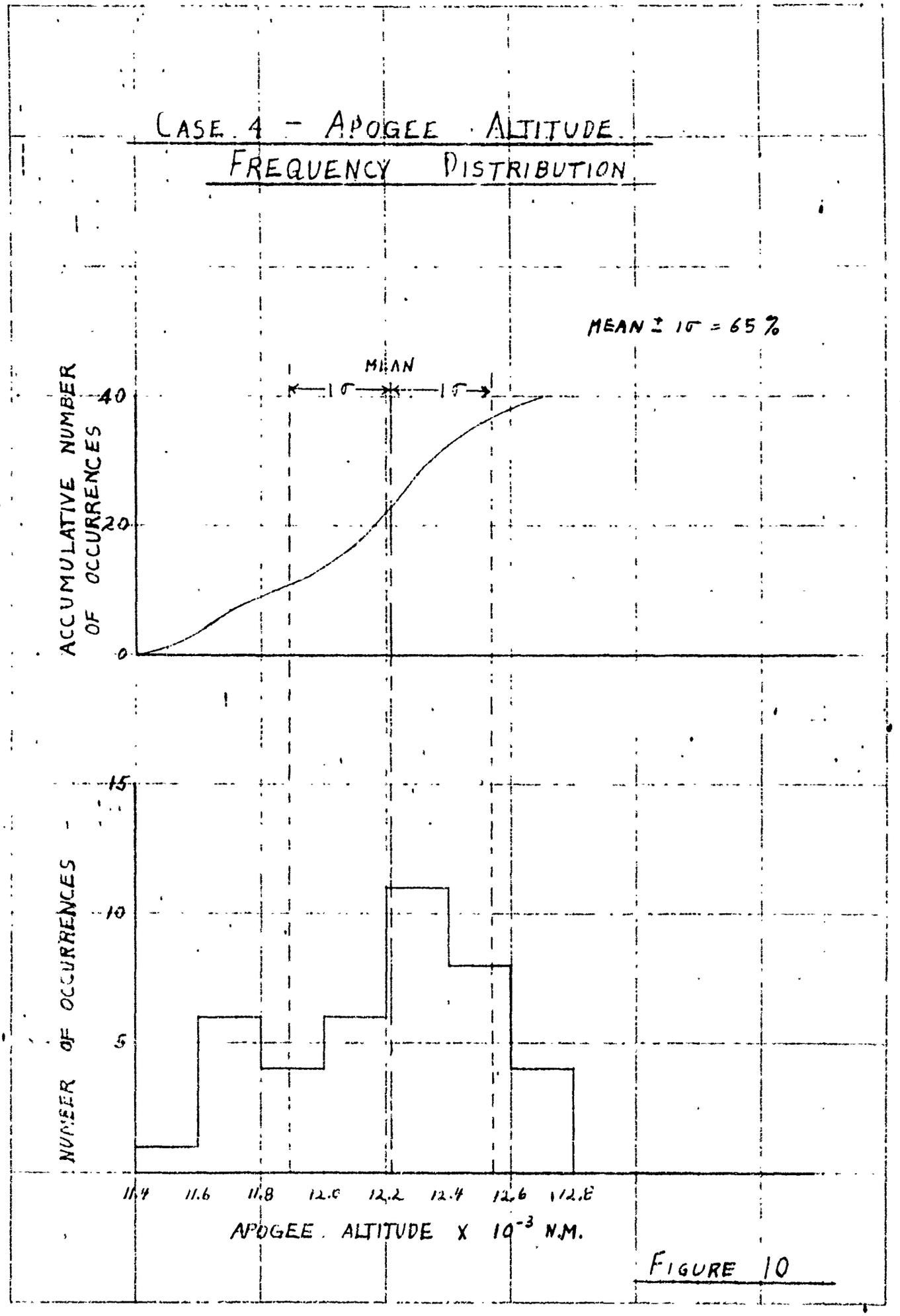
CASE 4 - APOGEE ALTITUDE
FREQUENCY DISTRIBUTION
MEAN ± 1σ = 65 %
MEAN
1σ
1σ
ACCUMULATIVE NUMBER OF OCCURRENCES
40
20
0
NUMBER OF OCCURRENCES
15
10
5
11.4
11.6
11.8
12.0
12.2
12.4
12.6
12.8
APOGEE ALTITUDE X 10⁻³ N.M.

FIGURE 10

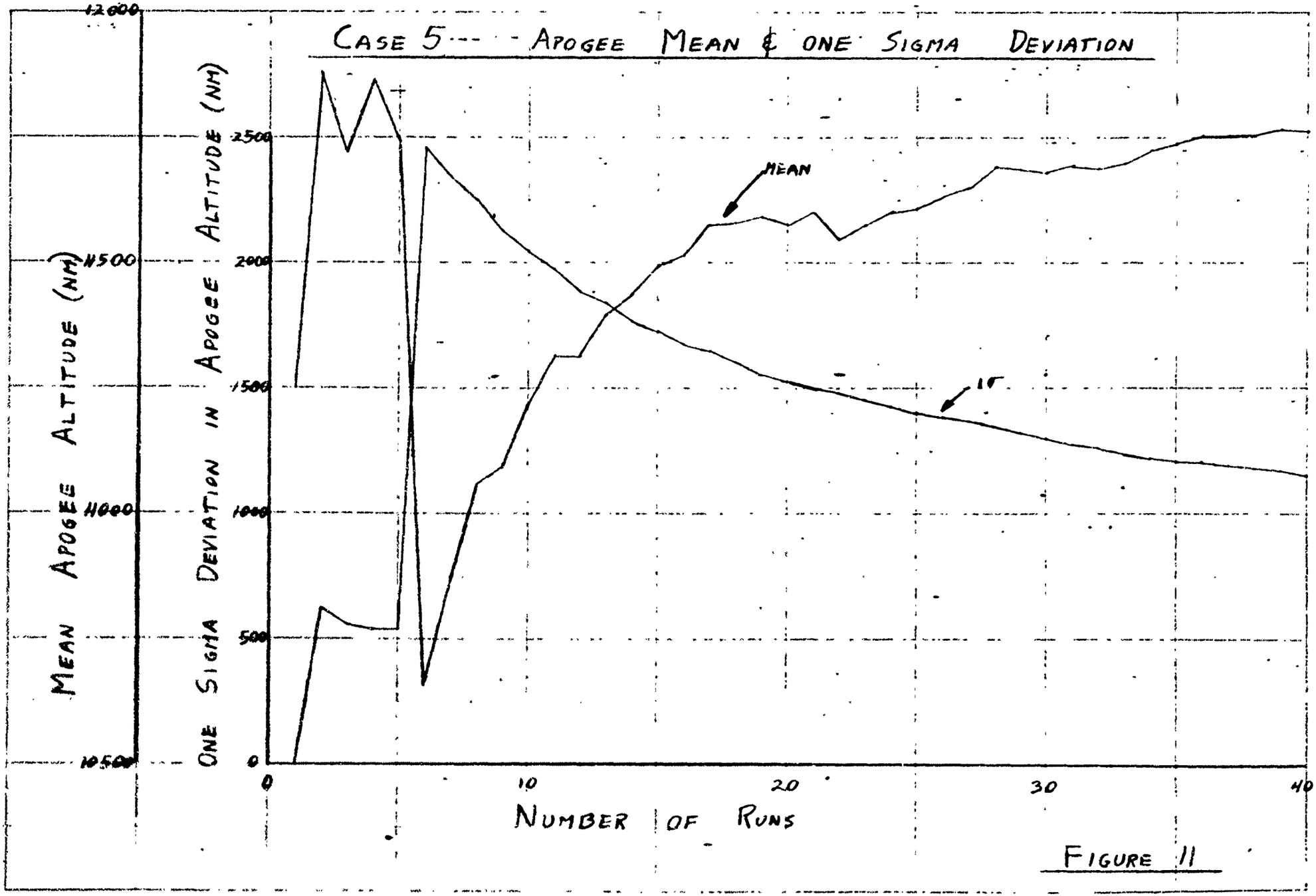
CASE 5 --- APOGEE MEAN & ONE SIGMA DEVIATION
MEAN APOGEE ALTITUDE (NM)
ONE SIGMA DEVIATION IN APOGEE ALTITUDE (NM)
12000
11500
11000
10500
2500
2000
1500
1000
500
0
MEAN
1σ
0
10
20
30
40
NUMBER OF RUNS

FIGURE 11

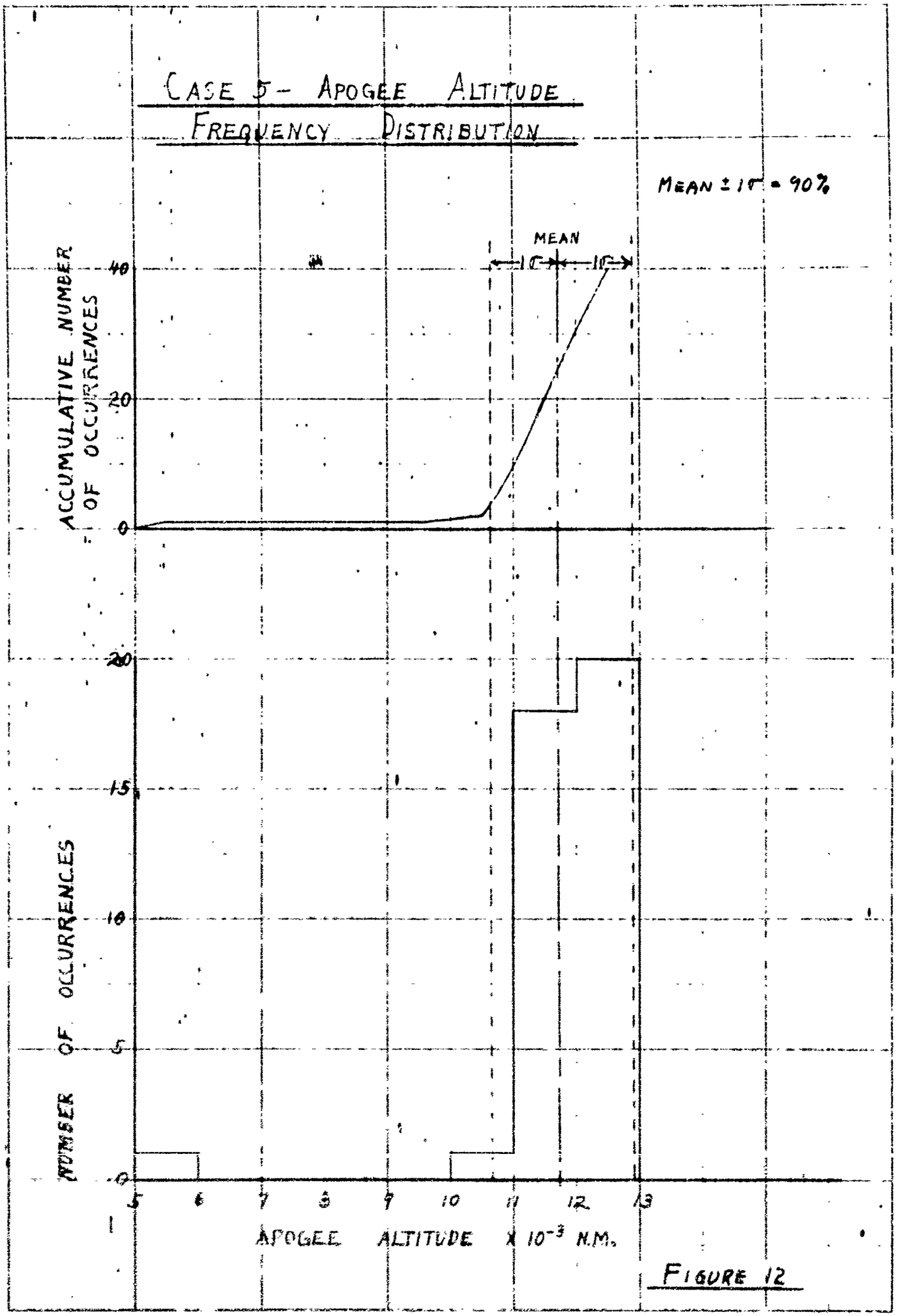
CASE 5 - APOGEE ALTITUDE FREQUENCY DISTRIBUTION
MEAN ± 1σ = 90%
MEAN
ACCUMULATIVE NUMBER OF OCCURRENCES
40
20
0
NUMBER OF OCCURRENCES
20
15
10
5
0
5
6
7
8
9
10
11
12
13
APOGEE ALTITUDE X 10⁻³ N.M.

FIGURE 12

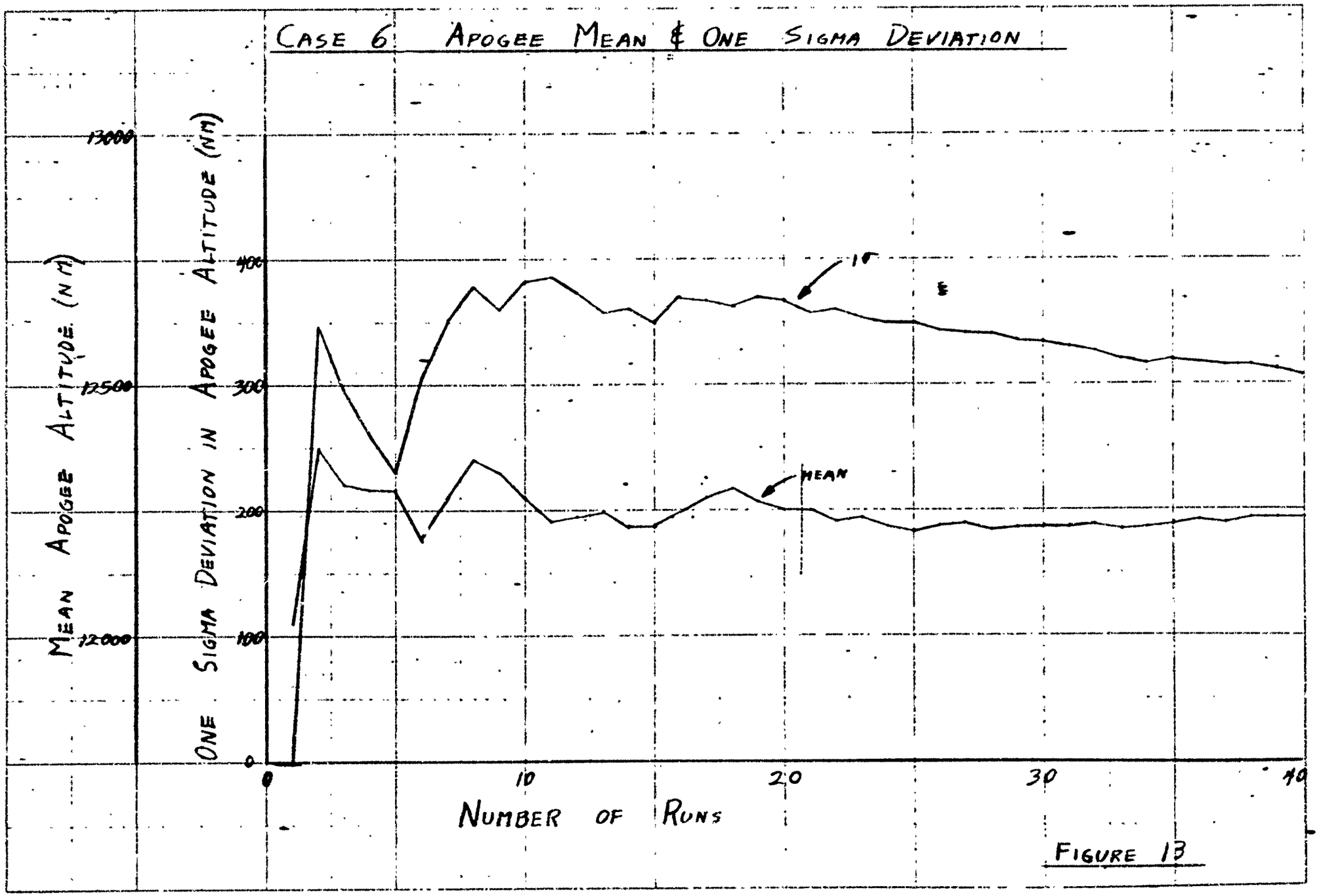
CASE 6 APOGEE MEAN & ONE SIGMA DEVIATION
MEAN APOGEE ALTITUDE (NM)
ONE SIGMA DEVIATION IN APOGEE ALTITUDE (NM)
13000
12500
12000
400
300
200
100
0
1σ
MEAN
0
10
20
30
40
NUMBER OF RUNS

FIGURE 13

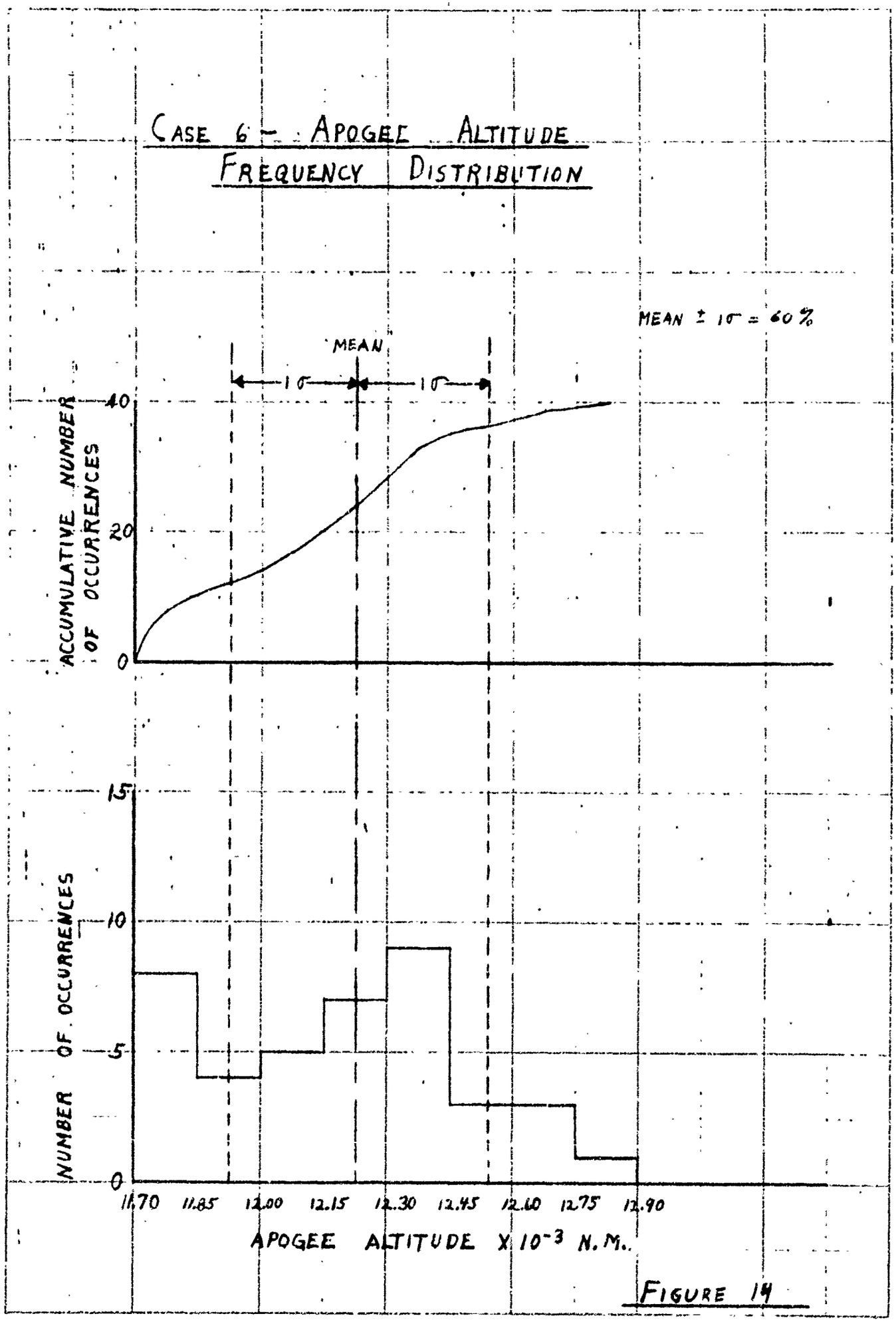
CASE 6 – APOGEE ALTITUDE FREQUENCY DISTRIBUTION
MEAN ± 1σ = 60 %
MEAN
1σ
1σ
ACCUMULATIVE NUMBER OF OCCURRENCES
40
20
0
NUMBER OF OCCURRENCES
15
10
5
0
11.70
11.85
12.00
12.15
12.30
12.45
12.60
12.75
12.90
APOGEE ALTITUDE X 10⁻³ N.M.

FIGURE 14

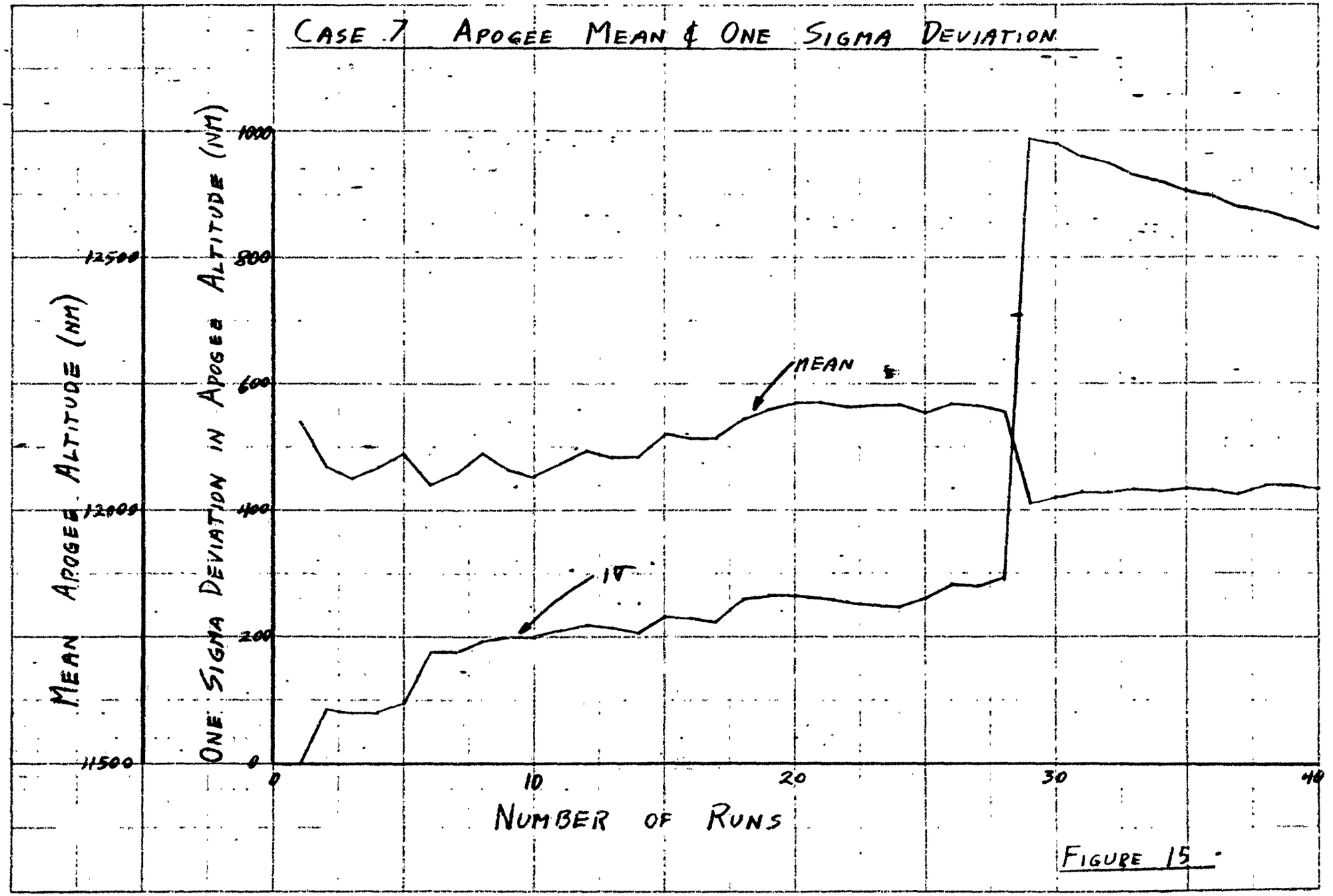
CASE 7 APOGEE MEAN & ONE SIGMA DEVIATION
MEAN APOGEE ALTITUDE (NM)
ONE SIGMA DEVIATION IN APOGEE ALTITUDE (NM)
1000
800
600
400
200
0
12500
12000
11500
MEAN
1σ
0
10
20
30
40
NUMBER OF RUNS

FIGURE 15

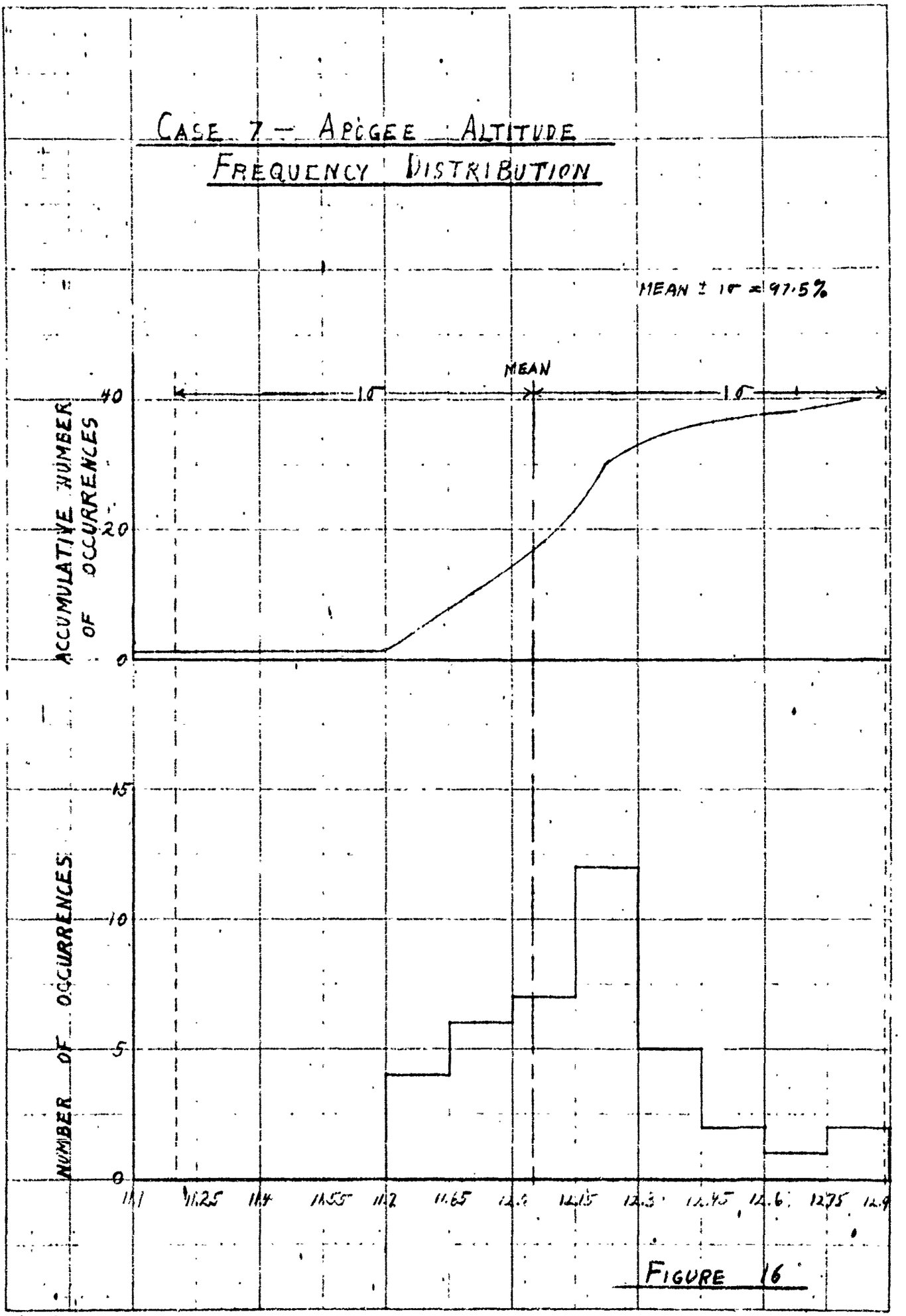
CASE 7 – APOGEE ALTITUDE
FREQUENCY DISTRIBUTION
MEAN ± 1σ = 97.5%
MEAN
1σ
1σ
ACCUMULATIVE NUMBER OF OCCURRENCES
40
20
0
NUMBER OF OCCURRENCES
15
10
5
0
11.1
11.25
11.4
11.55
11.7
11.85
12.0
12.15
12.3
12.45
12.6
12.75
12.9

FIGURE 16

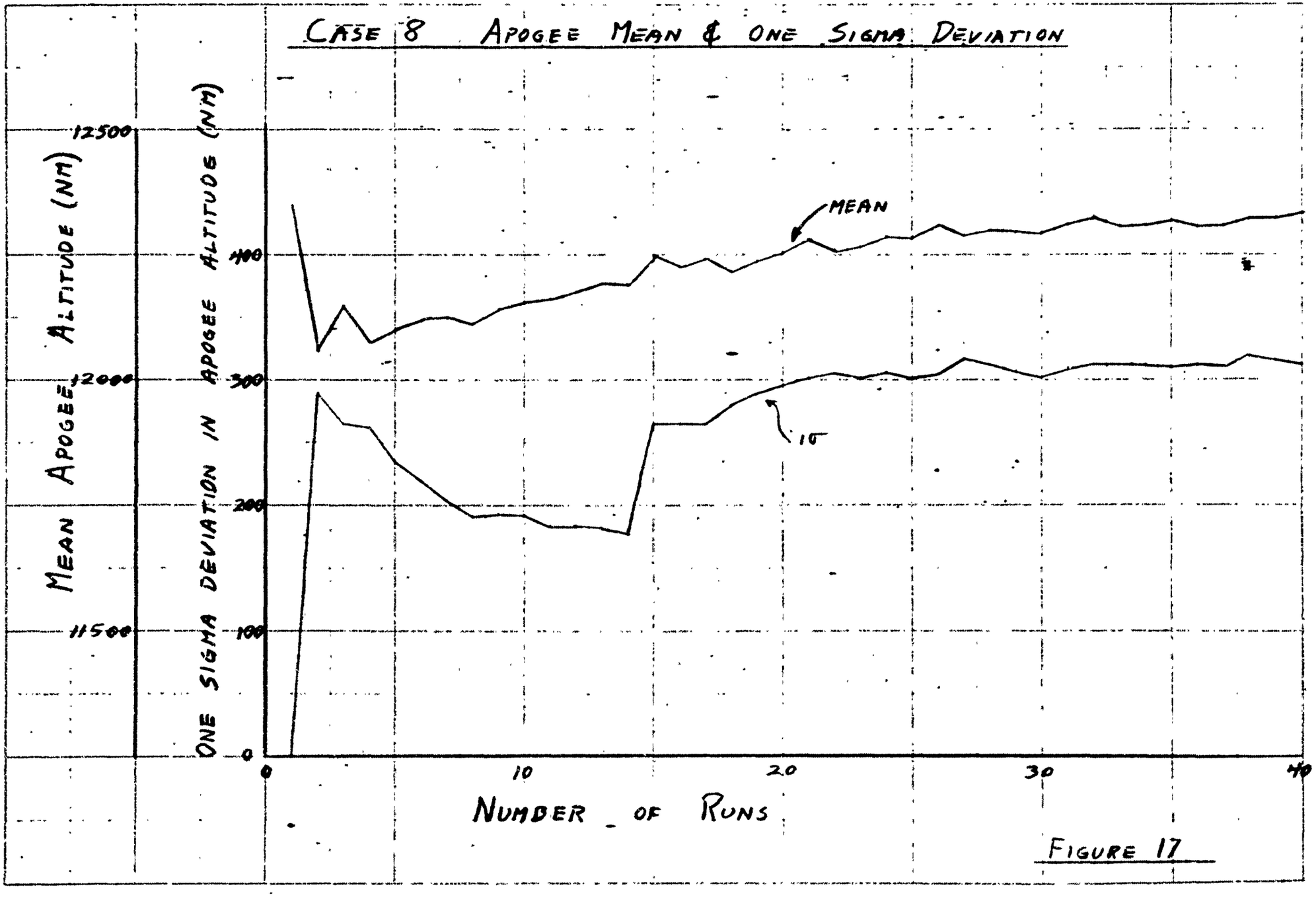
CASE 8 APOGEE MEAN & ONE SIGMA DEVIATION
MEAN APOGEE ALTITUDE (NM)
ONE SIGMA DEVIATION IN APOGEE ALTITUDE (NM)
12500
12000
11500
400
300
200
100
0
MEAN
1σ
0
10
20
30
40
NUMBER OF RUNS

FIGURE 17

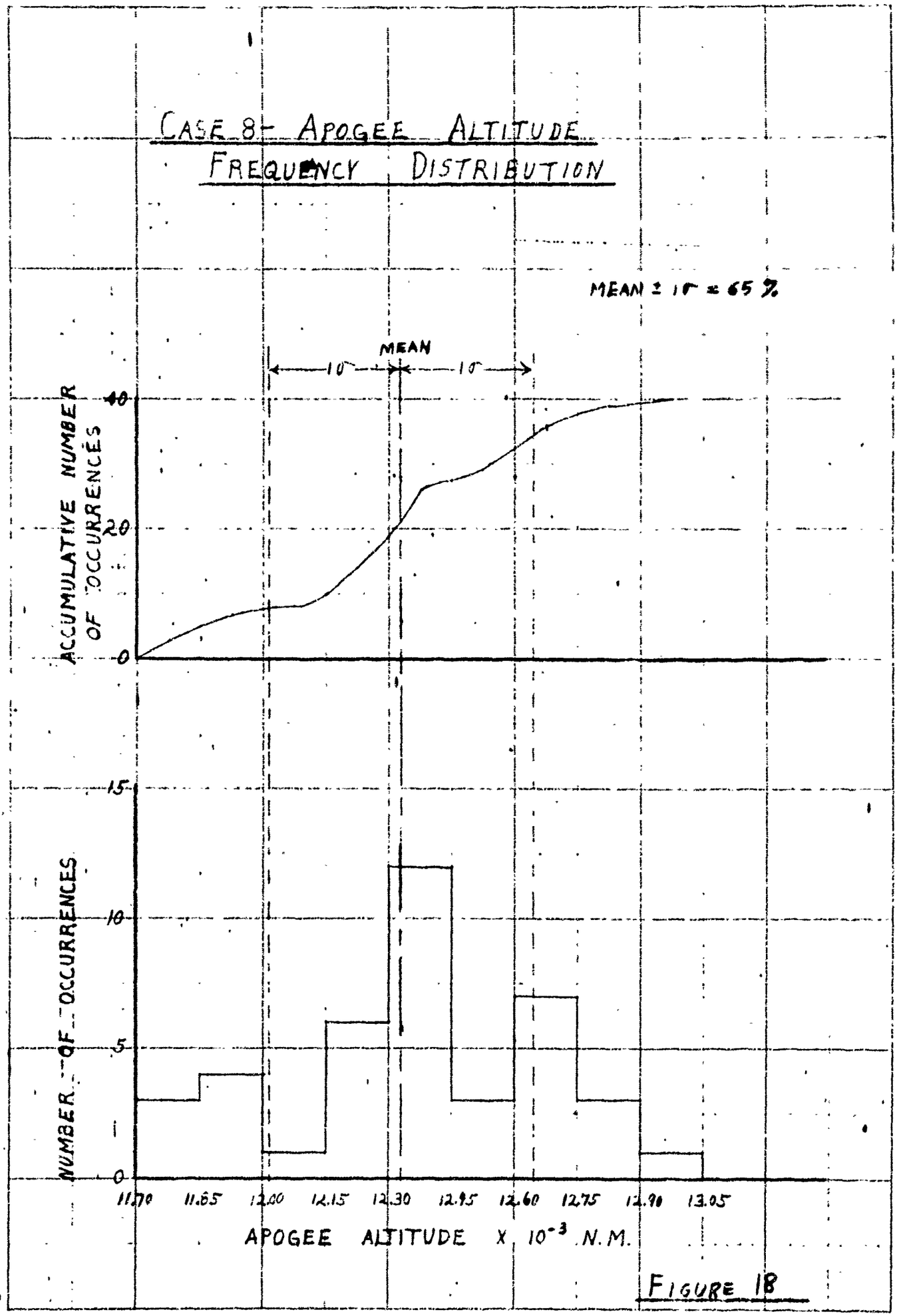
CASE 8- APOGEE ALTITUDE FREQUENCY DISTRIBUTION
MEAN ± 1σ = 65 %
MEAN
1σ
1σ
ACCUMULATIVE NUMBER OF OCCURRENCES
40
20
0
NUMBER OF OCCURRENCES
15
10
5
0
11.70
11.85
12.00
12.15
12.30
12.45
12.60
12.75
12.90
13.05
APOGEE ALTITUDE X 10⁻³ N.M.

FIGURE 18

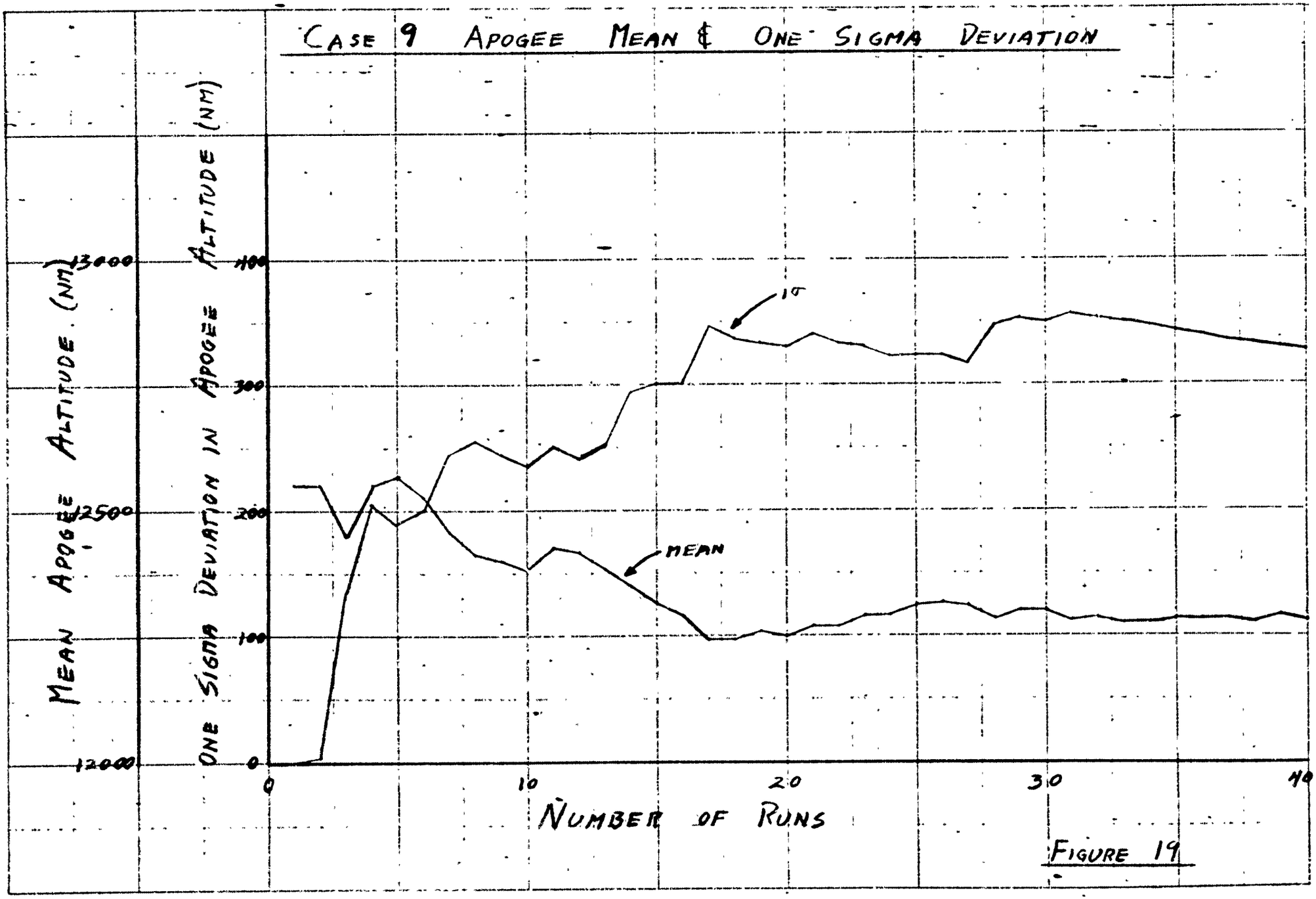
CASE 9 APOGEE MEAN & ONE SIGMA DEVIATION
MEAN APOGEE ALTITUDE (NM)
13000
12500
12000
ONE SIGMA DEVIATION IN APOGEE ALTITUDE (NM)
400
300
200
100
0
1σ
MEAN
0
10
20
30
40
NUMBER OF RUNS

FIGURE 19

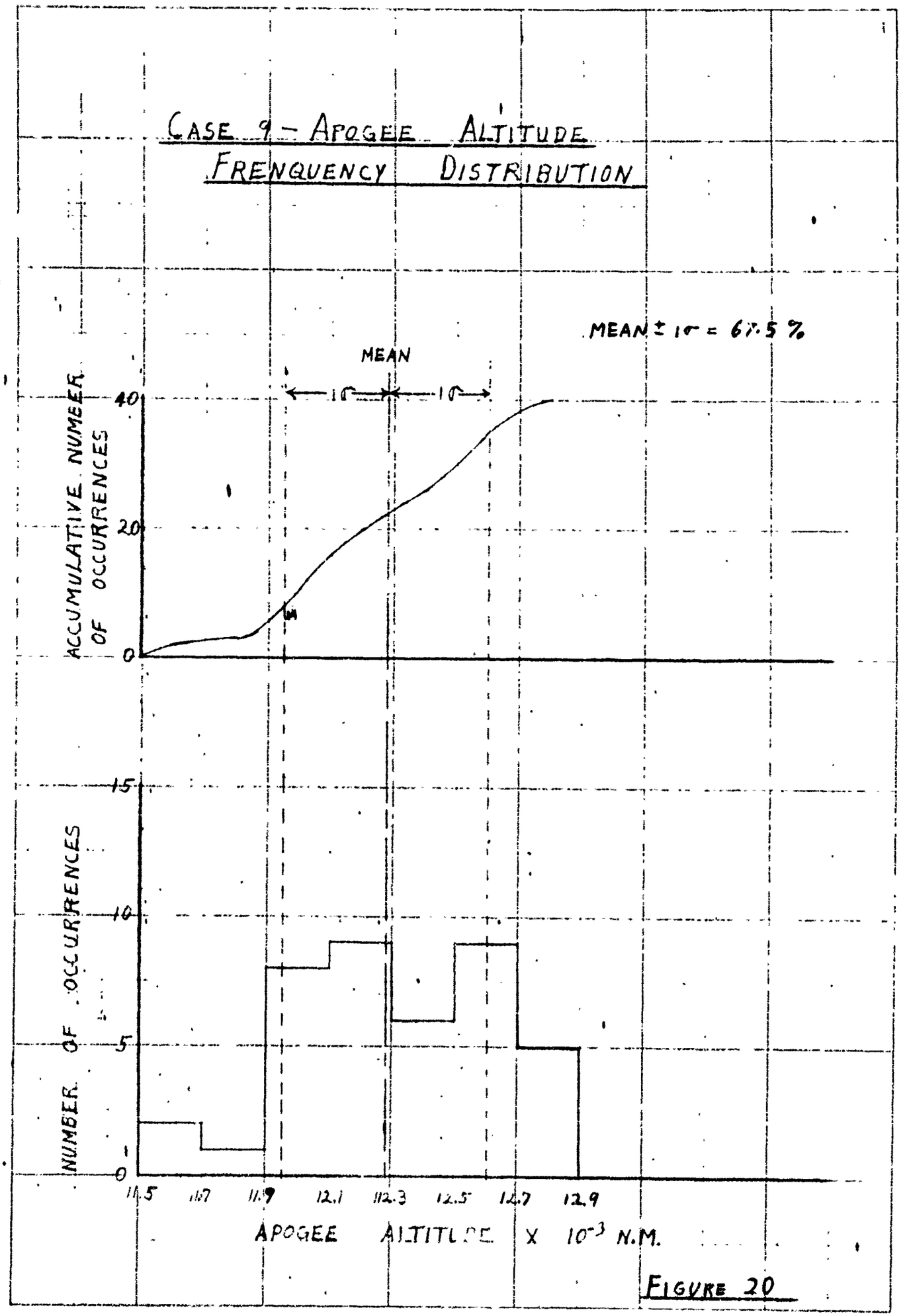
CASE 9 – APOGEE ALTITUDE
FREQUENCY DISTRIBUTION
MEAN ± 1σ = 67.5 %
MEAN
1σ
1σ
ACCUMULATIVE NUMBER OF OCCURRENCES
40
20
0
15
10
5
0
NUMBER OF OCCURRENCES
11.5
11.7
11.9
12.1
12.3
12.5
12.7
12.9
APOGEE ALTITUDE X 10⁻³ N.M.

FIGURE 20

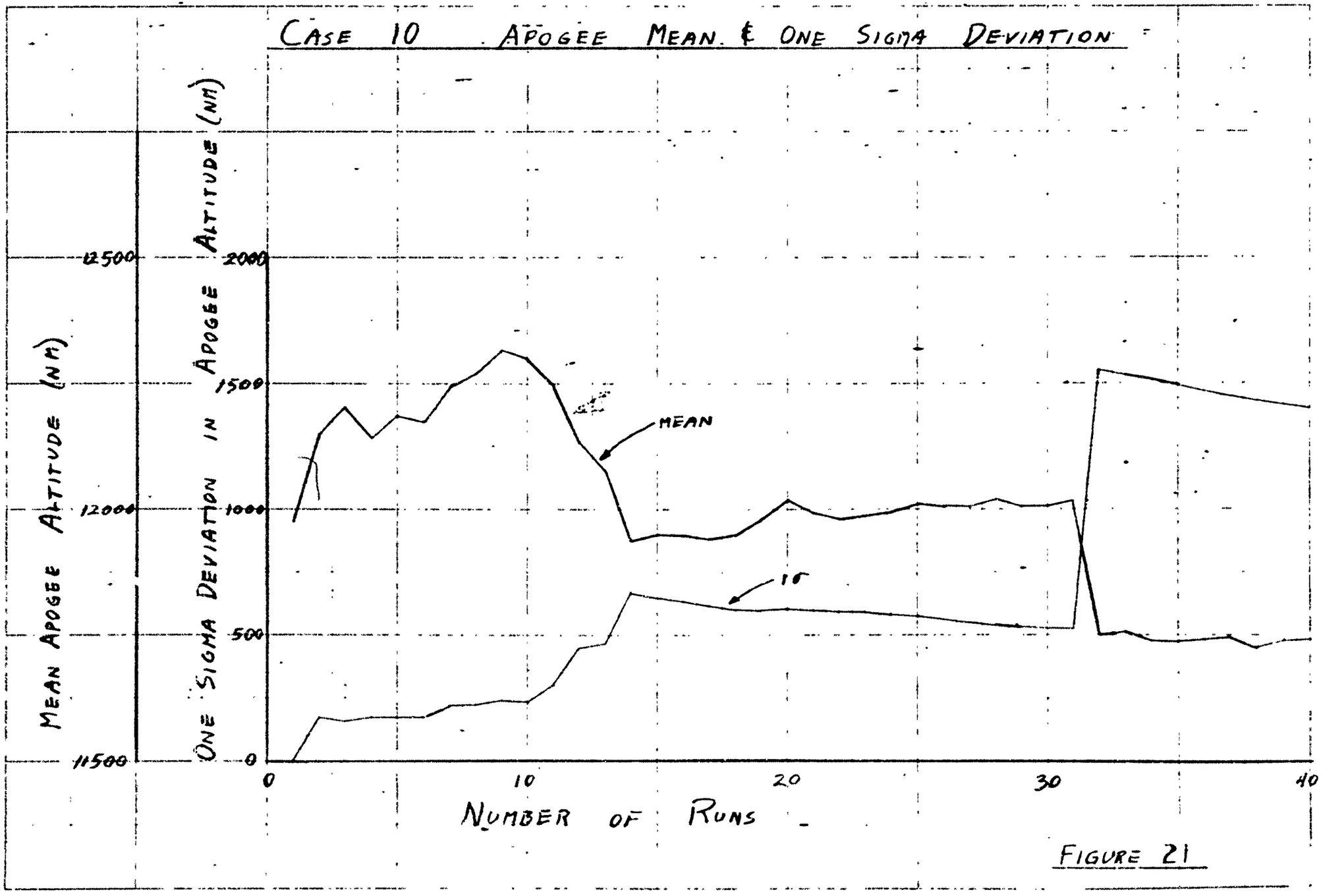
CASE 10 APOGEE MEAN & ONE SIGMA DEVIATION
MEAN APOGEE ALTITUDE (NM)
ONE SIGMA DEVIATION IN APOGEE ALTITUDE (NM)
12500
12000
11500
2000
1500
1000
500
0
MEAN
1σ
0
10
20
30
40
NUMBER OF RUNS

FIGURE 21

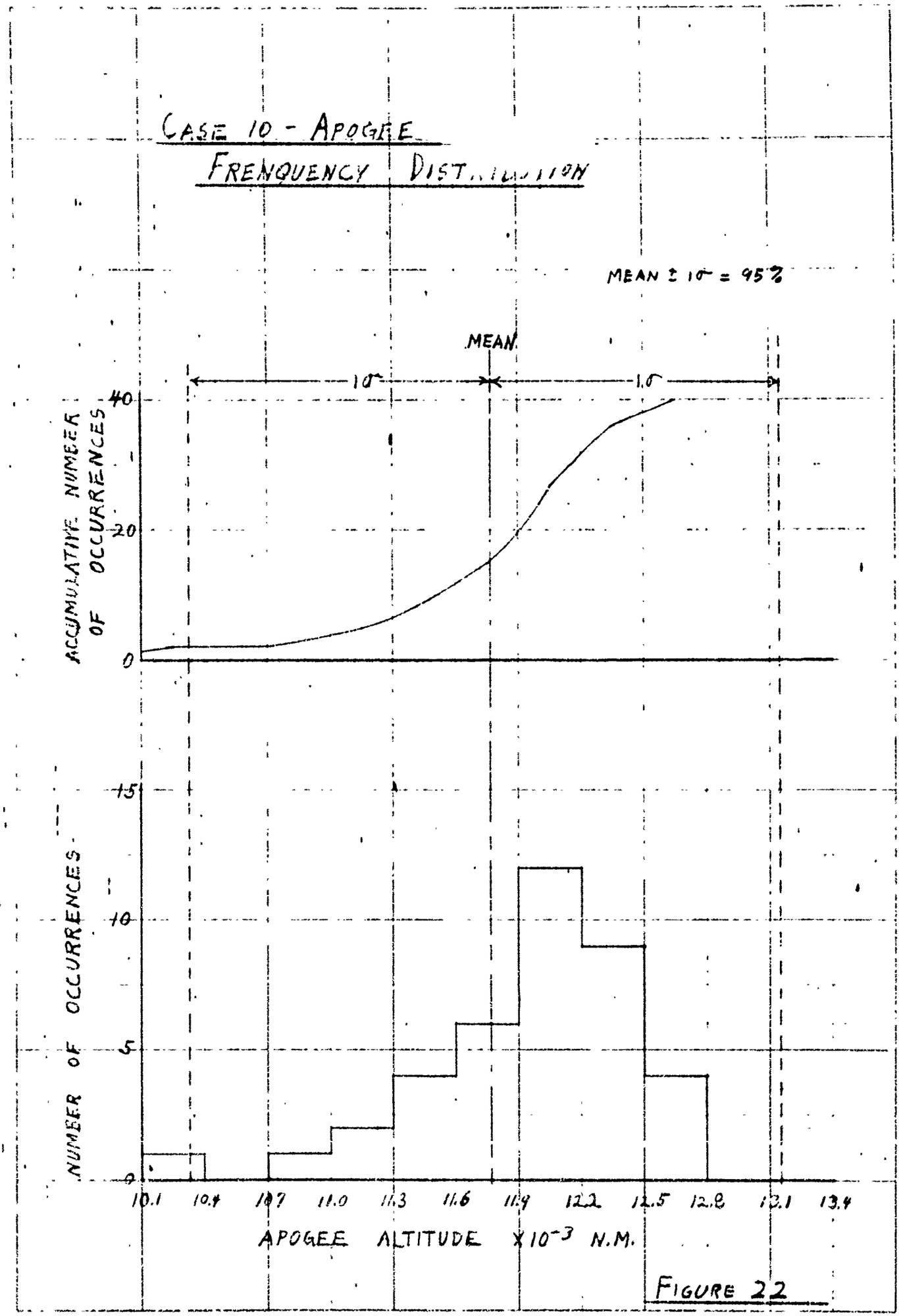
CASE 10 - APOGEE
FREQUENCY DISTRIBUTION
MEAN ± 1σ = 95%
MEAN
1σ
1σ
ACCUMULATIVE NUMBER OF OCCURRENCES
40
20
0
NUMBER OF OCCURRENCES
15
10
5
0
10.1
10.4
10.7
11.0
11.3
11.6
11.9
12.2
12.5
12.8
13.1
13.4
APOGEE ALTITUDE X10⁻³ N.M.

FIGURE 22

EFFECT OF DECREASING SPIN RATE

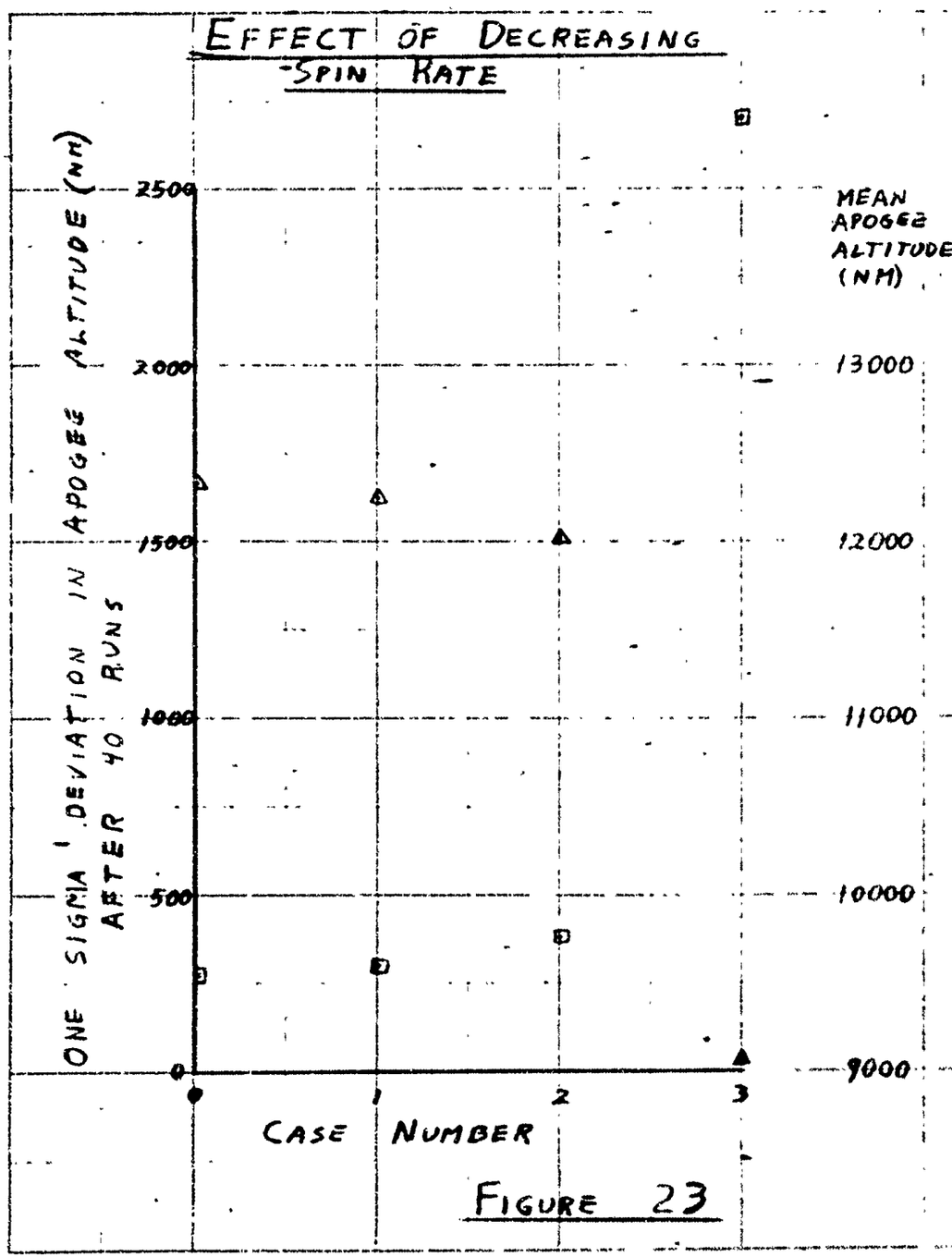

FIGURE 23

EFFECT OF INCREASING C.G. OFFSET

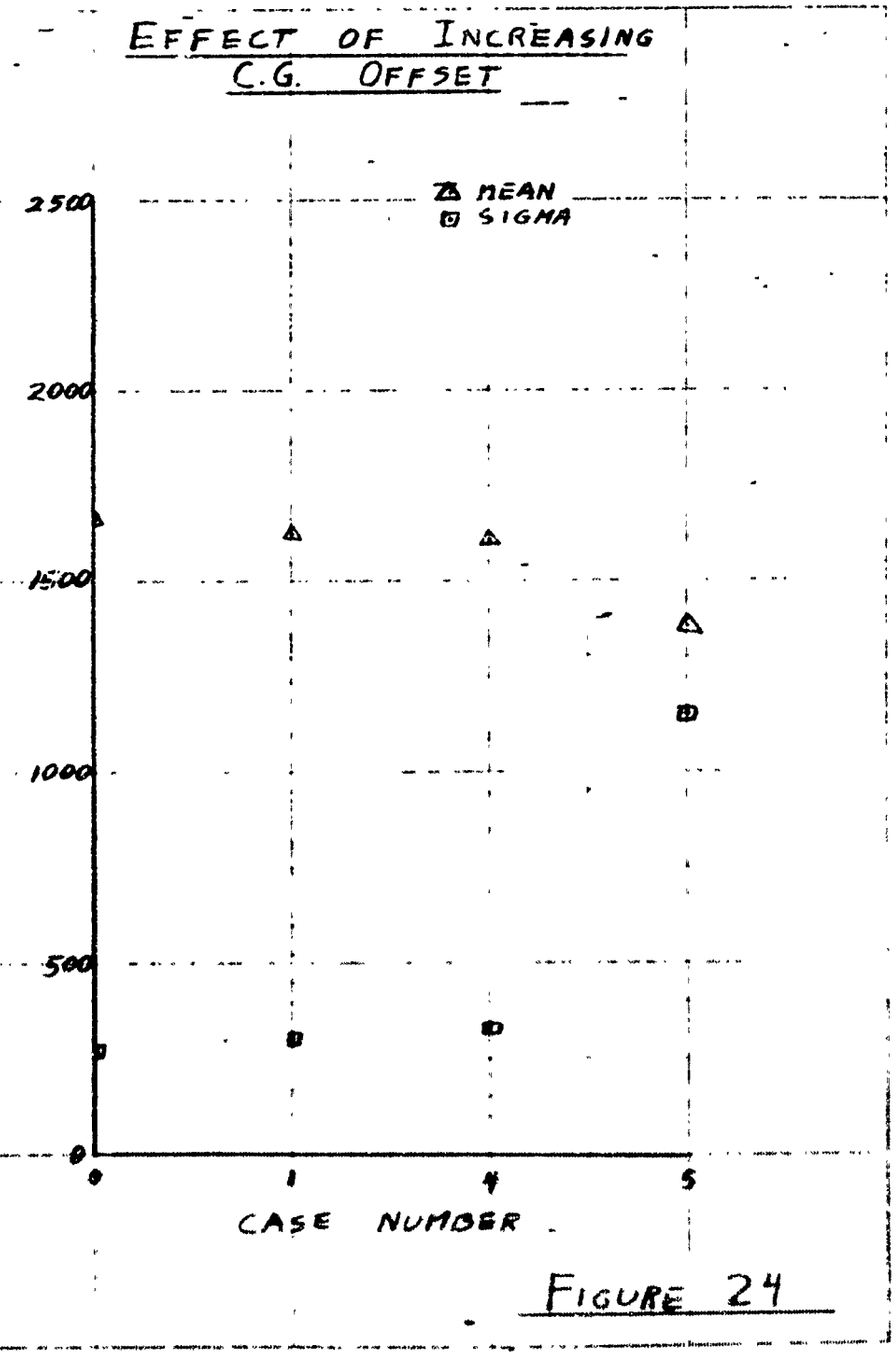

FIGURE 24

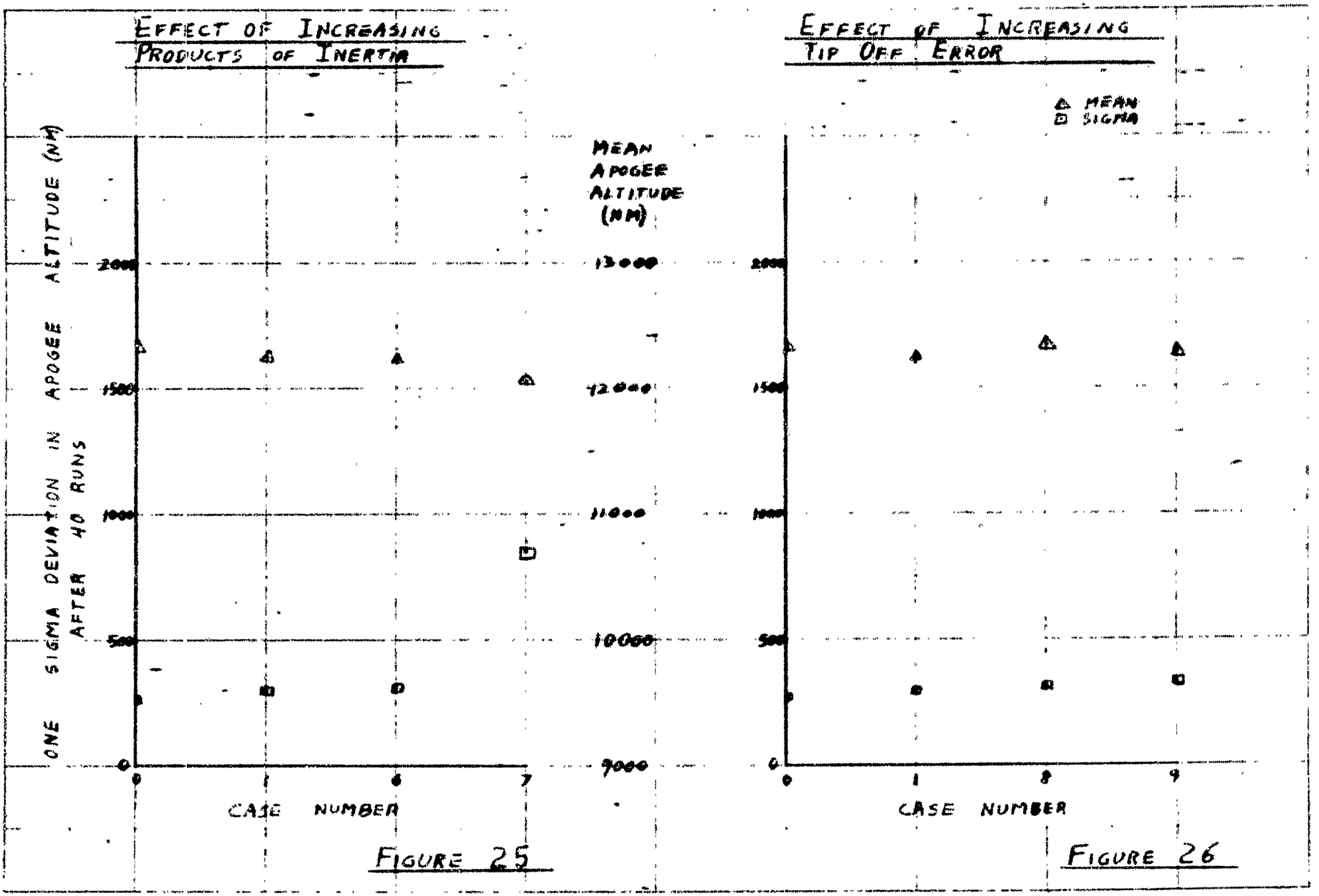

FIGURE 25

FIGURE 26

TABLE I

ION VARYING INPUT DATA WITH TOLERANCES

Variable		Symbol	Nominal	1 Sigma	Units
Weight		W	175.40	0.563	Pounds
Moments of Inertia	Roll	A	1.3216	0.0044	Slug-ft^2
	Pitch	B	3.666	0.0122	Slug-ft^2
	Yaw	C	3.666	0.0122	Slug-ft^2
Rates	Roll	P	0.0	0.010	Deg/Sec
	Pitch	Q	0.0	0.010	Deg/Sec
	Yaw	R	0.0	0.010	Deg/Sec
Position From Nominal	Roll	ϕ	0.0	0.670	Deg
	Pitch	θ	0.0	0.670	Deg
	Yaw	ψ	0.0	0.670	Deg
Propellant Wt.		WP	73.60	0.2453	Pounds
Velocity		V	21649.5	0.0	Feet/Sec
Latitude		θ_0	- 32.0	0.0	Deg
Longitude		ϕ_0	10.0	0.0	Deg
Altitude		h	9120000.0	0.0	Feet
Change in Rates due to Separation	Roll	ΔP	1080.0	3.60	Deg/Sec
	Pitch	ΔQ	0.0	0.0	Deg/Sec
	Yaw	ΔR	0.0	0.0	Deg/Sec
Change in Velocity Due to Separation	Axial	ΔV_1	2.0	0.0067	Feet/Sec
	Normal (y)	ΔV_2	0.0	0.0033	Feet/Sec
	Normal (z)	ΔV_3	0.0	0.0033	Feet/Sec
Spin Up Time		ΔT_2	0.34	0.0011	Sec
Push Time		ΔT_3	0.20	0.00067	Sec
Coast Time		ΔT_4	5.00	0.0167	Sec

TABLE I (CON'T)

Variable		Symbol	Nominal	1 Sigma	Units
Orbit Inclination		i	32.30	0.0	Deg
Impulse		I	21200.0	212.0	
Thrust Distance From C.G.	Axial	R_1	0.9833	0.0069	Feet
	Normal (y)	R2	0.0	0.0028	Feet
	Normal (z)	R_3	0.0	0.0028	Feet
Direction Cosines of Thrust	X	i_x	1.0	0.0	
	Y	i_y	0.0	0.0024	
	Z	i_z	0.0	0.0024	
Average Thrust		F	1308.64	0.0	Pounds
Rocket Burn Time		t_B	16.20	0.252	Seconds

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DEFINITION OF CONTROLLED VARIABLES

CASE	Spin Rate (RPM)	3 Sigma C.G. Offsets (Inches)	3 Sigma Products of Inertia (% of Moments)	3 Sigma Tip off error (Degrees)
0	180	0	0	0
1	180	.5	1	.25
2	120	.5	1	.25
3	60	.5	1	.25
4	180	1.0	1	.25
5	180	1.5	1	.25
6	180	.5	2	.25
7	180	.5	3	.25
8	180	.5	1	.50
9	180	.5	1	.75
10	180	1.5	1	.75

CASE #	APOGEE ALTITUDE (N.M.)	PERIGEE ALTITUDE (N.M.)	SEMI-MAJOR AXIS (N.M.)	ECCENTRICITY	INCLIN-ATION (DEGREES)	APOGEE LATITUDE (DEGREES)	APOGEE LONGITUDE (DEGREES)	TIME TO APOGEE (MIN)	PERIOD (MIN)	TIME TO ASCENDING NODE (MIN)
0 degrees	12289.18	1500.9312	10335.24	.521916	32.300	32.022	135.203	219.504	439.525	46.224
60 degrees	12343.82	1500.9331	10362.56	.523176	32.300	32.021	134.974	220.771	441.273	46.245
120 degrees	12333.26	1500.9353	10357.28	.522933	32.300	32.021	135.005	220.558	440.936	46.246
0 MEAN	12324.9	1500.8784	10353.07	0.522666	32.304	32.015	134.976	220.461	440.695	46.317
STD DEV	265.7	0.3768	132.91	0.006120	0.020	0.034	1.108	4.261	8.488	0.325
1 MEAN	12243.9	1500.7623	10312.50	0.520776	32.292	32.025	135.519	219.237	438.115	46.042
STD DEV	302.0	0.6306	151.04	0.006964	0.035	0.066	1.652	4.778	9.642	0.395
2 MEAN	12007.8	1499.6461	10193.52	0.515247	32.299	32.005	136.544	215.504	430.601	46.004
STD DEV	379.2	1.4884	189.71	0.009001	0.073	0.183	3.235	5.851	12.020	1.622
3 MEAN	9066.7	1487.5073	8717.30	0.416689	32.365	31.585	148.227	172.291	343.658	44.873
STD DEV	2695.1	52.4277	1357.53	0.117689	0.218	1.639	14.574	37.329	75.063	3.271
4 MEAN	12218.7	1500.3854	10299.72	0.520200	32.308	32.023	135.697	218.854	437.307	46.180
STD DEV	325.5	0.9681	162.89	0.007616	0.044	0.118	1.508	5.287	10.356	0.576
5 MEAN	11766.9	1500.2714	10073.76	0.507375	32.296	32.020	137.346	211.524	423.454	45.688
STD DEV	1145.6	0.8757	572.83	0.038925	0.068	0.126	4.750	10.741	23.602	1.155
6 MEAN	12235.2	1500.6070	10308.06	0.520580	32.307	32.012	135.353	219.035	437.834	46.066
STD DEV	307.7	0.6306	153.87	0.007139	0.043	0.090	1.506	4.830	9.008	0.722
7 MEAN	12048.4	1500.4755	10214.60	0.515234	32.307	32.002	135.565	216.162	432.148	46.261
STD DEV	850.1	0.7346	425.01	0.026045	0.060	0.102	3.672	12.728	25.425	0.976

TABLE III

MEAN AND ONE SIGMA RESULTS AFTER 40 RUNS

TABLE III (CON'T)

CASE #	APOGEE ALTITUDE (N.M.)	PERIGEE ALTITUDE (N.M.)	SEMI-MAJOR AXIS (N.M.)	ECCENTRICITY	INCLINATION (DEGREES)	APOGEE LATITUDE (DEGREES)	APOGEE LONGITUDE (DEGREE)	TIME TO APOGEE (MIN)	PERIOD (MIN)	TIME TO ASCENDING NODE (MIN)
3 MEAN	12329.2	1500.7872	10355.18	0.522741	32.295	32.025	[illegible]	220.578	440.540	[illegible]
STD DEV	[illegible]	0.3371	156.53	0.007230	0.036	0.065	[illegible]	5.017	[illegible]	[illegible]
5 MEAN	12280.5	1500.6861	10330.56	0.521620	32.303	32.020	[illegible]	219.797	439.256	46.223
STD DEV	328.8	.5638	164.43	0.007654	0.040	0.072	1.7[illegible]	5.158	10.472	0.666
10 MEAN	11739.2	1500.1932	10059.86	0.505130	32.289	32.028	137.485	211.653	422.907	45.763
STD DEV	1406.7	.5076	703.42	0.054503	0.063	0.131	5.575	19.912	40.240	1.0[illegible]
One Minute Coast MEAN	12189.6	1498.6835	10284.30	0.519708	32.307	32.050	136.591	218.768	436.305	45.657
STD DEV	229.3	3.2852	115.28	0.005249	0.059	0.197	2.575	3.955	7.341	1.733
Eliptical Initial Orbit MEAN	7461.0	4001.4380	9171.41	0.188553	37.344	32.228	130.651	164.286	367.426	100.700
STD DEV	150.9	1.9654	74.64	0.006593	0.164	0.816	2.246	3.007	4.462	1.240

APPENDIX

SUMMARY

RA	RP	A	E	I	THETA A	PHI A	TA	PERIOD	TN
12264.6366	1500.9608	10322.9806	0.52134535	32.290	32.040	135.547	219.584	438.748	45.977
12359.7120	1500.9551	10370.5154	0.52353989	32.277	32.059	135.461	221.190	441.782	45.712
12308.0164	1500.6652	10344.5226	0.52237071	32.302	31.960	134.303	219.951	440.122	46.663
12555.8492	1500.9201	10468.5665	0.52800588	32.309	32.015	134.045	224.142	448.062	46.451
12414.6387	1500.9416	10397.9720	0.52479932	32.291	32.025	134.739	221.917	443.537	46.135
12703.2672	1500.8860	10542.2584	0.53130841	32.290	32.006	133.302	226.468	452.801	46.355
12131.5057	1500.8666	10256.3680	0.51824579	32.307	32.000	135.532	217.302	434.508	46.405
12715.8582	1500.6271	10548.4246	0.53160693	32.308	31.955	132.608	226.474	453.199	46.892
11752.7089	1500.7453	10066.9089	0.50919124	32.290	31.976	136.690	211.206	422.524	46.246
12241.9562	1500.7894	10311.5547	0.52083159	32.310	31.981	134.846	218.983	438.020	46.593
11898.6229	1500.8869	10139.9368	0.51271208	32.300	32.005	136.519	213.631	427.130	46.209
13031.4050	1500.9615	10706.3651	0.53848545	32.288	32.041	132.476	231.925	463.415	46.166
12590.4158	1500.8727	10485.8262	0.52878729	32.300	32.001	133.708	224.638	449.171	46.460
12454.8433	1500.7714	10417.9891	0.52572870	32.320	31.977	133.960	222.374	444.819	46.789
12495.5179	1500.9495	10438.4156	0.52663972	32.345	32.065	134.982	223.383	446.128	46.484
12062.2217	1500.9495	10221.7675	0.51660696	32.278	32.063	136.712	216.474	432.311	45.609
12402.5426	1500.9249	10391.9155	0.52452397	32.304	32.018	134.687	221.694	443.150	46.335
12010.5609	1500.8438	10195.8843	0.51539018	32.305	31.993	135.924	215.356	430.670	46.377
11915.3207	1500.8497	10148.2671	0.51311574	32.289	31.996	136.316	213.853	427.657	46.159
12288.7709	1500.8368	10334.9857	0.52191336	32.316	31.991	134.803	219.775	439.513	46.605
12382.2084	1500.8423	10381.7072	0.52406439	32.298	32.094	135.924	221.712	442.497	45.701
12320.6516	1500.8447	10350.9301	0.52264903	32.306	31.993	134.681	220.284	440.531	46.499
12129.6779	1500.9457	10255.4937	0.51819701	32.288	32.065	136.464	217.550	434.452	45.737
12740.0259	1500.7409	10560.5653	0.53213463	32.299	31.975	132.751	226.939	453.981	46.670
12048.0192	1500.9498	10214.6663	0.51627088	32.308	32.030	136.272	216.100	431.861	46.181
12688.2706	1500.9244	10534.7794	0.53097203	32.298	32.018	133.533	226.278	452.320	46.360
12566.3984	1500.9595	10473.8607	0.52824070	32.345	32.039	134.334	224.411	448.402	46.688
12089.7522	1500.9407	10235.5283	0.51725770	32.310	32.024	136.030	216.739	433.184	46.257
12161.5461	1500.8824	10271.3962	0.51894911	32.322	32.003	135.469	217.797	435.463	46.549
12020.9301	1500.9194	10201.1066	0.51563086	32.284	32.016	136.170	215.607	431.001	46.001
12264.2712	1500.9621	10322.7986	0.52133679	32.315	32.048	135.679	219.618	438.736	46.198
12348.7465	1500.7755	10364.9429	0.52330105	32.332	31.977	134.411	220.686	441.426	46.077
12512.7947	1500.9350	10447.0468	0.52703219	32.288	32.023	134.308	223.479	446.681	46.154
12283.5468	1500.9325	10332.4215	0.52178545	32.307	32.022	135.229	219.814	439.350	46.302
11984.4359	1500.6947	10132.7471	0.51238529	32.329	31.960	136.042	213.242	426.676	46.789
12372.9069	1500.9192	10377.0948	0.52384544	32.307	32.015	134.775	221.211	442.202	46.380
12231.7721	1500.9344	10306.5352	0.52058416	32.309	32.021	135.417	218.983	437.700	46.317
12475.5461	1500.9323	10428.4211	0.52618770	32.305	32.020	134.433	222.874	445.487	46.348
12424.4052	1500.9469	10402.8579	0.52502199	32.274	32.064	135.283	222.248	443.850	45.651
12451.7810	1500.9535	10416.5491	0.52564566	32.316	32.031	134.687	222.541	444.727	46.383

CASE 0

RPM 180

CG 0

PROD 0

TIP OFF 0

SUMMARY

RA	RP	A	E	I	THETA A	PHI A	TA	PERIOD	TN
12200.4825	1500.9537	10294.8999	0.52004045	32.299	32.053	135.983	218.754	436.959	45.974
12054.3041	1500.5286	10217.8481	0.51646273	32.345	32.145	137.941	216.709	432.062	45.760
11991.1632	1500.8965	10186.2117	0.51492483	32.307	32.082	137.278	215.432	430.057	45.775
11720.2167	1500.8752	10050.7278	0.50838814	32.287	32.042	137.741	210.974	421.506	45.753
11899.1783	1501.0234	10140.2828	0.51271524	32.289	32.033	136.909	213.760	427.152	45.910
12172.2119	1500.8625	10276.7190	0.51920021	32.213	32.073	136.540	218.298	435.802	44.694
12076.2107	1500.9240	10228.7493	0.51693939	32.320	32.041	136.324	216.596	432.754	46.247
12653.6200	1500.8705	10517.4271	0.53020332	32.364	32.084	134.592	225.993	451.203	46.605
12173.6780	1501.0441	10277.5430	0.51922109	32.288	32.035	135.846	218.118	435.854	45.961
12380.9252	1500.7337	10381.0112	0.52404295	32.295	31.968	134.110	221.148	442.453	46.560
12886.1619	1500.8230	10633.6743	0.53534360	32.290	31.980	132.203	229.313	458.704	46.591
12125.9587	1500.9785	10253.6505	0.51810721	32.302	32.069	136.550	217.513	434.335	45.856
12324.8531	1500.8159	10353.0164	0.52274801	32.308	32.012	134.927	220.430	440.664	46.388
12350.7513	1500.9647	10366.0398	0.52333325	32.234	32.059	135.518	221.054	441.496	45.164
12600.8190	1500.7888	10490.9858	0.52902704	32.319	31.981	133.415	224.728	449.502	46.803
12134.1138	1499.2749	10256.8762	0.51842485	32.282	31.832	133.423	216.687	434.540	47.145
12469.9344	1500.5607	10425.4294	0.52608739	32.341	31.927	133.338	222.444	445.295	47.316
12906.7231	1500.9268	10644.0070	0.53578491	32.296	31.996	132.350	229.716	459.372	46.558
12156.7083	1500.9264	10268.9991	0.51883254	32.216	32.016	135.558	217.741	435.311	45.207
12402.0349	1500.9323	10391.6655	0.52451182	32.278	32.019	134.686	221.685	443.134	46.025
12655.6969	1500.6859	10518.3733	0.53026313	32.283	32.113	135.195	226.206	451.263	45.433
12286.5375	1500.8881	10333.8947	0.52185792	32.255	32.080	136.128	220.132	439.444	45.242
12003.9806	1500.6538	10192.4991	0.51524787	32.320	32.124	137.876	215.825	430.456	45.622
11869.9435	1501.0022	10125.6548	0.51201338	32.335	32.034	137.059	213.308	426.228	46.391
12052.5352	1500.3659	10216.6324	0.51642112	32.253	31.935	134.886	215.752	431.985	46.200
12290.2097	1500.8535	10335.7135	0.52194541	32.307	32.028	135.281	219.942	439.560	46.264
12092.8079	1500.4555	10236.8136	0.51736570	32.278	32.138	137.930	217.351	433.266	44.986
11783.0023	1500.9100	10082.1379	0.50991627	32.248	32.002	136.879	211.779	423.483	45.608
12108.3414	1500.8270	10244.7660	0.51770408	32.318	32.005	135.704	216.956	433.771	46.466
11980.7833	1500.8929	10181.0199	0.51467783	32.281	32.038	136.654	215.068	429.729	45.798
12200.9481	1500.8089	10291.0603	0.51987545	32.257	32.031	135.653	218.523	436.714	45.632
11749.7042	1500.6278	10065.3479	0.50912679	32.283	32.113	138.787	211.783	422.426	45.176
12009.1362	1500.1246	10194.8123	0.51540978	32.316	31.894	134.740	214.963	430.602	47.099
12577.5195	1500.6370	10479.2601	0.52851453	32.287	31.963	133.216	224.265	448.749	46.563
12451.9757	1500.8895	10416.6145	0.52565478	32.300	32.075	135.335	222.738	444.731	45.890
12194.4886	1500.4915	10287.6720	0.51974817	32.283	31.944	134.510	218.065	436.499	46.518
12121.8389	1500.9902	10251.5963	0.51800951	32.282	32.044	136.179	217.333	434.205	45.806
12668.3549	1500.9344	10524.8265	0.53052753	32.271	32.017	133.577	225.947	451.679	46.048
12083.1125	1500.8854	10232.1809	0.51710517	32.350	32.114	137.344	217.018	432.972	46.064
12885.9456	1500.8690	10633.5891	0.53533555	32.305	32.005	132.582	229.422	458.698	46.595

CASE 1
RPM 180
CG 1/2"
PROD 1%
TIP OFF 1/4°

SUMMARY

	RA	RP	A	E	I	THETA A	PHI A	TA	PERIOD	TA
6	12317.5369	1497.4457	10347.5047	0.52279929	32.252	31.747	131.644	219.272	440.338	47.376
5	12029.6545	1500.8324	10205.4254	0.51584437	32.347	31.978	135.714	215.618	431.275	46.927
4	11949.6164	1499.5803	10164.5803	0.51400176	32.350	31.858	134.689	213.932	428.713	47.604
5	12194.7359	1499.7812	10287.4424	0.51980650	32.198	31.892	133.536	217.767	436.484	45.876
2	11570.8806	1500.5451	9975.8748	0.50473246	32.468	32.164	139.826	209.074	416.806	46.784
6	12240.1931	1500.9150	10315.2360	0.52099042	32.197	32.053	135.820	219.402	438.254	44.658
9	12804.5113	1500.2938	10592.5847	0.53359111	32.364	31.900	131.744	227.747	456.048	47.820
4	11866.7854	1499.8827	10120.5179	0.51187631	32.182	31.915	135.054	212.533	425.904	45.412
3	11615.6626	1499.5050	9997.7656	0.50592092	32.196	32.153	140.874	210.125	418.178	43.379
8	11817.3278	1495.8193	10096.7554	0.51112997	32.396	31.538	132.521	210.957	424.405	49.472
1	12515.7280	1498.3562	10446.2240	0.52724180	32.324	32.239	138.127	224.587	446.628	44.709
3	12118.1949	1499.5059	10248.9872	0.51803163	32.228	32.165	138.845	218.039	434.039	43.934
4	11946.8566	1500.9059	10164.0632	0.51386688	32.309	32.066	137.196	214.653	428.655	45.907
4	11929.2073	1500.6136	10155.0923	0.51346622	32.265	32.108	138.016	214.593	428.088	45.032
2	12393.6042	1500.9158	10387.4419	0.52432067	32.333	32.058	135.280	221.718	442.864	46.371
3	11889.5751	1499.4045	10134.6716	0.51260519	32.221	32.167	139.873	214.456	426.797	43.720
4	11566.7483	1496.7144	10171.9131	0.51465411	32.328	31.639	132.454	213.494	429.152	48.507
7	12430.4184	1500.4669	10405.6234	0.52519436	32.258	32.129	136.490	222.704	444.027	44.884
3	11810.1964	1497.0324	9993.7963	0.50597210	32.304	31.663	133.924	207.899	417.929	48.005
6	12290.7654	1498.8332	10334.9811	0.52210701	32.262	31.801	132.395	219.053	439.513	47.171
9	12582.7525	1499.8738	10481.5100	0.52868856	32.295	31.870	132.105	224.010	448.893	47.228
6	12390.7939	1500.8760	10386.0168	0.52425864	32.366	32.014	134.731	221.505	442.773	47.011
1	12816.9949	1500.8423	10599.1005	0.53382609	32.315	32.019	133.053	228.364	456.468	46.576
1	11701.3879	1499.0881	10040.4199	0.50806142	32.330	32.222	140.905	211.574	420.858	44.777
3	11656.5472	1500.9328	10018.5219	0.50682172	32.351	32.101	138.821	210.223	419.507	46.044
6	12254.1936	1500.7124	10317.6378	0.52112059	32.366	31.955	134.586	219.115	438.407	47.327
1	11282.8284	1499.1857	9831.1909	0.49758156	32.343	32.220	142.395	204.989	407.771	44.871
6	12311.4854	1500.7386	10346.2938	0.52244538	32.195	32.095	136.491	220.665	440.235	44.247
5	12018.1722	1500.1955	10199.3657	0.51561916	32.353	32.168	138.461	216.234	430.891	45.669
2	11498.2836	1500.0356	9939.3414	0.50296330	32.207	32.142	140.842	208.148	414.518	43.712
5	12136.1165	1499.3629	10257.6215	0.51846535	32.255	32.180	138.864	218.350	434.607	44.228
1	11356.8598	1497.6050	9867.3158	0.49958114	32.261	32.225	143.276	206.461	410.021	43.531
2	11418.0149	1500.7650	9899.5739	0.50089257	32.191	31.998	138.109	205.991	412.033	44.790
5	12194.4518	1499.9660	10285.3917	0.52008150	32.308	31.610	131.165	216.982	436.354	48.552
5	12014.7865	1499.4975	10192.3239	0.51535299	32.266	32.182	139.328	216.252	430.444	44.356
7	11946.1317	1500.6241	10163.7097	0.51384819	32.345	32.020	136.557	214.451	428.633	46.604
2	11534.0857	1501.0136	9957.7335	0.50378272	32.447	32.059	138.680	208.118	415.669	47.223
7	12162.5067	1500.4711	10271.7107	0.51900389	32.366	31.916	134.500	217.516	435.483	47.510
5	12080.8979	1499.5421	10230.4020	0.51715250	32.404	31.808	133.823	215.901	432.859	48.404
2	11466.8943	1500.0470	9923.6525	0.50217636	32.231	32.154	141.054	207.685	413.537	43.968

CASE 2

RPM 120

CG .5"

PROD 1%

TIP OFF 1/4°

SUMMARY

RA	RP	A	E	I	THETA A	PHI A	TA	PERIOD	TN
9266.7264	1494.5265	[illegible].8083	0.64056053	32.213	31.579	141.472	171.750	346.553	46.313
7628.9385	1496.3703	[illegible].8363	0.38307259	32.533	31.485	148.338	148.441	299.428	47.944
9390.4602	1497.8873	[illegible].3556	0.44418375	32.135	32.152	150.769	176.636	350.305	41.729
11958.2445	1499.2287	10168.9185	0.51426393	32.145	31.899	134.074	213.883	428.963	45.124
9868.9139	1489.8014	9119.5396	0.45940437	32.224	31.266	137.539	180.111	364.306	47.585
9380.0662	1500.4636	8880.8969	0.44367719	32.584	32.192	148.339	175.778	350.100	46.765
10233.5127	1495.1603	9304.5183	0.46957576	32.284	32.269	148.977	189.602	375.447	42.969
9423.7504	1500.7154	8902.4148	0.44499359	32.526	31.943	145.547	175.604	351.373	47.502
10812.2081	1491.7832	9492.1776	0.48041795	32.312	32.309	148.937	195.720	386.862	42.760
2921.9584	1499.7153	5851.0187	0.12583953	33.095	31.575	165.388	88.024	177.704	44.735
11827.4135	1500.7572	10104.2671	0.51100472	32.386	32.122	138.398	212.984	424.878	46.320
11475.2025	1497.9825	9986.7744	0.50254089	32.438	31.663	135.045	205.977	413.732	49.095
10249.3893	1491.8868	9310.8198	0.47028632	32.281	31.401	136.854	186.112	375.828	48.205
8516.1418	1497.8262	8447.1659	0.41542428	32.417	31.629	145.839	161.346	324.768	47.373
8681.2836	1499.1199	8530.3837	0.42097542	32.562	31.717	146.366	164.106	329.579	48.179
11493.9288	1500.9404	9997.6185	0.50278599	32.576	32.098	139.215	207.602	414.410	48.116
10846.8230	1498.3292	9612.2579	0.48622779	32.589	31.636	137.709	196.281	394.226	49.998
9459.4906	1494.1405	8916.9974	0.44663858	32.257	32.253	152.404	178.167	352.237	42.292
11751.1124	1493.0235	10062.2498	0.50973138	32.235	32.234	143.847	213.187	422.231	42.410
10774.2147	1491.9176	9573.2480	0.48480397	32.255	32.255	148.198	198.164	391.829	42.255
10802.5369	1494.7289	9568.8147	0.48534716	32.440	32.376	146.949	198.306	392.785	44.445
8807.6532	1497.8370	8592.9270	0.42533914	32.158	32.155	153.046	168.133	333.211	41.587
9080.3473	1500.7986	8730.7549	0.43407179	32.153	32.087	148.897	171.185	341.260	42.715
9029.4399	1496.5982	8703.2009	0.43276273	32.460	32.362	152.906	171.554	339.645	44.370
8858.3048	1499.2560	8618.9623	0.42691038	32.643	31.692	145.716	166.678	334.726	48.916
10407.1111	1494.0171	9390.7460	0.47456795	32.141	31.647	137.116	188.812	380.678	45.824
9150.6227	1500.7617	8765.8740	0.43634331	32.173	32.087	148.545	172.191	343.321	43.068
3887.8331	1162.7182	5965.4575	0.22840787	32.275	22.450	218.917	114.091	192.740	33.270
9494.5509	1498.9905	8936.9525	0.44733147	32.177	32.156	149.599	177.949	353.420	42.374
11905.2423	1500.8482	10143.2272	0.51287397	32.181	32.076	137.732	214.107	427.338	44.118
8760.6788	1497.1798	8589.1112	0.42381871	32.240	31.683	144.557	164.759	331.826	45.879
11942.0630	1500.6610	10161.5438	0.51377045	32.207	32.098	137.956	214.796	428.496	44.293
4303.0194	1496.9692	6340.1762	0.22129118	32.166	32.163	170.083	107.809	211.183	39.873
10330.8722	1499.7359	9355.4360	0.47197353	32.573	31.772	140.705	188 745	378.533	49.053
12067.5104	1500.3594	10224.1168	0.51677575	32.284	31.924	134.765	215.970	432.460	46.605
3706.4738	1471.6252	6029.2313	0.18533465	32.072	30.381	148.822	92.218	195.839	41.479
2415.0857	1469.7643	5382.6069	0.08781259	32.253	27.939	146.231	74.083	165.195	41.727
10205.6865	1500.5257	9293.2880	0.46835743	32.602	32.201	145.328	188.133	374.767	47.240
2223.0099	1489.2467	5296.3101	0.06927118	32.907	32.872	186.700	86.683	161.238	41.724
9533.9178	1496.1004	8955.1909	0.44877978	32.445	31.507	141.256	175.963	354.503	48.673

CASE 3
RPM 60
CG .5°
PROD 1%
TIP OFF 1/4°

SUMMARY

RA	RP	A	E	I	THETA A	PHI A	TA	PERIOD	TV
12693.9326	1500.9467	10537.6216	0.53109641	32.343	32.035	133.766	226.445	452.503	46.727
12259.4557	1500.8513	10320.3353	0.52123328	32.334	32.091	136.316	219.724	438.579	46.107
12753.3539	1500.9276	10567.5726	0.53242721	32.297	32.079	134.161	227.601	454.433	45.911
12403.8217	1500.0401	10392.1128	0.52461814	32.307	32.156	137.089	222.417	443.163	45.206
12762.3824	1500.7926	10571.7694	0.53262559	32.265	32.106	134.648	227.892	454.704	45.276
11923.2631	1497.6365	10150.6316	0.51354571	32.354	31.685	133.147	212.979	427.806	48.497
12264.5641	1500.7753	10322.8514	0.52135734	32.299	32.105	136.578	219.889	438.740	45.588
12599.2312	1500.7547	10490.1748	0.52899387	32.271	31.977	133.281	224.661	449.450	46.304
12535.1371	1500.7393	10458.1201	0.52755169	32.333	31.965	133.527	223.627	447.391	47.022
11786.2312	1499.2846	10082.9397	0.51011644	32.287	31.821	134.705	211.151	423.534	47.117
12248.9242	1500.8289	10315.0585	0.52099053	32.297	31.985	134.862	219.109	438.243	46.431
12141.7628	1501.0157	10261.5710	0.51847554	32.329	32.032	135.944	217.603	434.839	46.424
12723.1792	1500.9099	10552.2263	0.53174889	32.318	32.061	134.010	227.024	453.444	46.278
12331.7850	1501.0146	10356.5817	0.52289312	32.371	32.045	135.364	220.683	440.892	46.854
11957.9391	1500.0934	10169.1481	0.51418987	32.219	31.913	134.835	214.119	428.977	45.908
11659.0876	1500.7973	10020.1243	0.50689442	32.350	31.960	136.970	209.707	419.582	46.920
12519.1744	1500.5748	10450.0564	0.52720287	32.316	31.949	133.351	223.297	446.874	46.944
11751.4257	1500.8992	10066.3442	0.50914842	32.370	32.089	138.278	211.663	422.489	46.362
12338.4061	1500.9285	10359.8491	0.52305190	32.279	32.066	135.652	220.880	441.100	45.673
11777.0740	1499.8262	10078.6318	0.50985332	32.320	32.184	139.868	212.554	423.262	45.049
12190.7328	1500.6982	10285.8973	0.51964522	32.317	32.126	137.169	218.800	436.386	45.627
11769.6820	1500.6227	10075.3342	0.50961383	32.379	31.938	136.315	211.377	423.055	47.364
12409.4729	1499.9507	10394.8937	0.52475391	32.244	32.156	137.271	222.566	443.340	44.377
12388.1564	1500.8031	10384.6616	0.52420357	32.224	32.073	135.656	221.734	442.686	44.909
12445.5566	1500.9996	10413.4601	0.52550051	32.316	32.044	134.869	222.489	444.529	46.299
12075.9586	1500.8409	10228.5815	0.51693960	32.283	32.003	135.761	216.422	432.743	46.092
12499.5929	1500.0085	10439.9827	0.52680091	32.287	32.169	136.885	224.003	446.228	44.914
12332.3383	1501.0008	10356.8514	0.52290688	32.320	32.027	135.105	220.614	440.909	46.420
12151.9221	1500.9338	10266.6099	0.51871984	32.308	32.036	135.951	217.778	435.159	46.174
12315.2117	1497.5911	10346.5833	0.52270294	32.231	32.204	139.383	221.536	440.253	43.435
11954.3071	1500.4310	10167.5509	0.51408035	32.345	31.925	135.378	214.226	428.876	47.185
11436.0990	1499.7713	9908.1171	0.50142362	32.408	32.214	141.314	207.242	412.566	45.772
12314.9380	1501.0166	10348.1592	0.52250459	32.241	32.037	135.294	220.373	440.354	45.410
11686.0192	1501.0166	10033.6998	0.50753973	32.301	32.065	138.213	210.540	420.435	45.739
12150.2189	1499.0802	10264.3313	0.51889102	32.313	31.730	132.460	216.651	435.014	47.996
12518.7864	1500.9233	10450.0367	0.52716863	32.380	31.981	133.831	223.438	446.873	47.404
12335.6991	1500.4381	10358.7505	0.52304866	32.294	32.142	136.952	221.231	441.030	45.226
12069.9313	1500.7755	10225.5353	0.51680208	32.279	31.998	135.732	216.309	432.550	46.077
12394.7654	1500.2058	10387.6675	0.52439875	32.288	31.909	133.317	221.138	442.878	46.864
11875.6868	1499.6767	10128.3636	0.51227476	32.313	31.837	134.657	212.678	426.399	47.333

CASE 4

RPM 180

C G 1.0"

PROD 1%

TIP OFF 1/4°

HC

SUMMARY

RA	RP	A	E	I	THETA A	PHI A	TA	PERIOD	TN
11251.7023	1500.2755	9816.1708	0.49670218	32.262	32.146	141.477	204.210	406.837	44.455
12512.2003	1500.8473	10446.7057	0.52702515	32.296	32.085	135.275	223.756	446.659	45.786
11399.1244	1500.9064	9890.1973	0.50040549	32.251	32.081	139.652	206.140	411.448	44.922
12293.1067	1500.6707	10337.0706	0.52202585	32.224	31.989	134.592	219.783	439.646	45.557
11249.6078	1500.6988	9815.3352	0.49661621	32.166	31.981	138.409	203.259	406.785	44.540
5258.7270	1500.8894	6819.9901	0.27550169	32.346	32.016	160.716	117.908	235.604	43.280
12124.1594	1498.6407	10251.5819	0.51823801	32.294	31.773	132.921	216.355	434.204	47.587
12368.2413	1498.7152	10373.6602	0.52390025	32.291	31.789	132.066	220.282	441.983	47.556
11376.0470	1500.9426	9878.6768	0.49981920	32.436	31.997	138.600	205.437	410.729	47.416
12295.4412	1500.7428	10338.2738	0.52207451	32.225	32.085	136.243	220.317	439.723	44.782
12300.6117	1500.6523	10340.8138	0.52220065	32.327	31.965	134.430	219.862	439.885	46.888
11308.5791	1500.9398	9844.9413	0.49810553	32.452	32.037	139.325	204.525	408.627	47.301
12442.8833	1500.9106	10412.0789	0.52544612	32.322	32.051	134.996	222.480	444.440	46.315
11981.2469	1499.7155	10180.6631	0.51477647	32.294	31.856	134.370	214.371	429.706	47.078
12236.2953	1500.9261	10308.7926	0.52068994	32.268	32.060	135.994	219.232	437.844	45.564
11826.1589	1500.5809	10103.5518	0.51098754	32.452	32.152	138.710	213.053	424.833	46.789
12611.6487	1500.7033	10496.3579	0.52927623	32.270	31.972	133.192	224.847	449.847	46.326
11701.4512	1498.4282	10040.1215	0.50811253	32.368	31.727	134.443	209.620	420.839	48.323
11789.0646	1500.9694	10085.1989	0.51005912	32.421	32.064	137.756	212.146	423.676	47.033
11180.1147	1498.6037	9779.5411	0.49498800	32.332	32.240	143.331	203.545	404.562	44.502
12122.0399	1499.9485	10251.1761	0.51809136	32.308	32.180	138.499	218.010	434.178	45.006
10306.2548	1498.8389	9342.7288	0.47135137	32.318	32.226	146.519	190.102	377.762	44.198
12237.5543	1500.5187	10309.2184	0.52074926	32.323	32.144	137.255	219.624	437.871	45.561
12210.9965	1499.8124	10295.5863	0.52018330	32.243	31.882	133.526	218.042	437.002	46.469
11850.1453	1500.9316	10115.7203	0.51154112	32.253	31.989	136.410	212.776	425.601	45.772
12296.3911	1499.6698	10338.2124	0.52217545	32.278	31.861	133.085	219.371	439.719	47.002
12101.8251	1501.0723	10241.6305	0.51753248	32.190	32.048	136.325	217.037	433.572	44.576
12681.6073	1501.0285	10531.4998	0.53081609	32.301	32.079	134.472	226.444	452.108	45.937
11585.1134	1500.3143	9982.8956	0.50510390	32.205	31.934	136.523	208.318	417.246	45.484
11576.9872	1499.9178	9978.6344	0.50493229	32.301	32.178	140.635	209.408	416.979	44.788
11946.3281	1500.5971	10163.6445	0.51387724	32.258	32.114	138.096	214.909	428.629	44.902
11620.1823	1499.8387	10000.1924	0.50600746	32.284	32.174	140.510	210.098	418.331	44.606
12039.3748	1499.8483	10209.7935	0.51614789	32.252	32.165	138.892	216.718	431.552	44.313
12479.5122	1500.6164	10430.2461	0.52630090	32.216	31.982	133.718	222.724	445.604	45.564
12342.4797	1500.6567	10361.7501	0.52316564	32.319	31.954	134.115	220.487	441.222	46.886
12290.4521	1500.9288	10335.8723	0.52194547	32.311	31.991	134.786	219.800	439.570	46.553
11821.3143	1499.4092	10100.5436	0.51095790	32.291	31.834	134.730	211.756	424.643	47.112
11767.2188	1499.9492	10073.7659	0.50960435	32.296	31.885	135.524	211.087	422.956	46.849
12215.4270	1500.5894	10298.1901	0.52022917	32.395	32.138	137.084	219.196	437.168	46.428
11677.5332	1500.6170	10029.2570	0.50736143	32.219	31.962	136.635	209.915	420.156	45.497

CASE 5

RPM 180

CG 1.5

PROD 1%

TIP OFF 1/4°

SUMMARY

RA	RP	A	E	I	THETA A	PHI A	TA	PERIOD	TN
12023.3077	1500.2694	10201.9705	0.51573559	32.262	31.919	134.819	215.231	431.056	46.388
12716.4923	1500.8788	10548.8674	0.53160274	32.333	32.058	134.000	226.905	453.227	46.467
12172.3802	1499.9474	10276.3457	0.51927179	32.293	31.880	133.858	217.483	435.778	47.006
12233.9286	1500.7736	10307.5330	0.52064617	32.283	32.084	136.360	219.299	437.763	45.554
12313.2112	1500.5869	10347.0809	0.52249637	32.325	31.952	134.226	220.017	440.285	46.948
11699.9255	1500.8025	10040.5459	0.50789685	32.290	32.100	138.735	210.929	420.865	45.360
12781.6211	1500.8673	10581.4260	0.53304506	32.316	32.026	133.280	227.819	455.327	46.531
12852.1354	1500.9335	10616.7163	0.53459100	32.275	31.993	132.491	228.809	457.607	46.310
12182.2198	1500.5961	10281.5898	0.51945390	32.300	32.139	137.498	218.752	436.112	45.302
11757.4081	1500.9032	10069.3375	0.50929394	32.346	32.075	138.062	211.699	422.677	46.188
11821.2715	1500.7711	10101.2032	0.51085501	32.245	31.986	136.476	212.304	424.685	45.691
12363.0125	1500.7381	10372.0573	0.52363164	32.286	32.119	136.458	221.540	441.880	45.331
12312.3446	1499.6788	10346.1936	0.52254319	32.344	31.836	132.991	219.616	440.228	47.804
11849.1514	1500.7379	10115.1265	0.51153160	32.317	32.112	138.295	213.321	425.563	45.633
12181.1174	1500.9641	10281.2227	0.51940095	32.360	32.072	136.323	218.389	436.088	46.494
12832.5555	1500.9397	10606.9296	0.53416099	32.343	32.031	133.160	228.669	456.974	46.808
12614.7471	1499.5840	10497.3474	0.52942723	32.285	31.850	131.726	224.442	449.911	47.255
12555.1223	1500.9590	10468.2224	0.52798665	32.245	32.046	134.484	224.261	448.040	45.468
11781.6726	1501.0548	10081.5455	0.50987311	32.303	32.045	137.565	211.964	423.446	45.940
11967.3306	1500.8566	10174.2755	0.51435968	32.305	32.095	137.561	215.110	429.302	45.651
12237.3516	1500.5896	10309.1523	0.52073932	32.302	31.952	134.482	218.792	437.866	46.689
11811.6202	1500.4926	10096.2383	0.51064206	32.295	32.127	138.784	212.827	424.372	45.226
12323.1460	1500.8776	10352.1936	0.52270412	32.332	32.082	135.915	220.696	440.612	46.167
12012.7451	1500.7867	10196.9478	0.51544632	32.322	31.991	135.902	215.385	430.737	46.575
11879.4963	1500.9465	10130.4033	0.51224762	32.314	32.003	136.582	213.326	426.528	46.367
12454.2931	1500.0624	10417.3596	0.52576810	32.252	31.900	132.811	222.010	444.778	46.535
12406.3374	1500.8931	10393.7971	0.52461311	32.374	31.993	134.467	221.693	443.270	47.201
11844.6892	1500.1472	10112.6001	0.51146797	32.368	31.882	135.387	212.361	425.404	47.592
12339.8396	1500.1599	10360.1815	0.52314140	32.223	31.925	133.495	220.248	441.122	46.009
12304.3463	1499.2598	10341.9849	0.52238940	32.333	31.804	132.655	219.370	439.960	47.860
11999.4583	1500.9203	10190.3711	0.51512050	32.254	32.055	136.852	215.446	430.321	45.352
12409.0020	1500.7715	10395.0686	0.52468295	32.353	31.980	134.224	221.664	443.352	47.102
12093.9052	1500.7298	10237.4993	0.51737124	32.369	32.123	137.389	217.213	433.309	46.209
12132.2576	1500.8564	10256.7388	0.51826420	32.312	32.015	135.729	217.373	434.531	46.354
12632.2334	1500.9022	10506.7496	0.52972288	32.250	32.040	134.063	225.467	450.516	45.601
12395.3536	1501.0055	10388.3615	0.52435354	32.225	32.049	135.168	221.716	442.923	45.141
12039.7375	1499.9739	10210.0376	0.51614716	32.376	32.191	138.670	216.660	431.567	45.752
12593.8468	1501.0360	10487.6233	0.52885247	32.332	32.030	134.099	224.816	449.286	46.620
12268.0867	1500.8721	10324.6613	0.52143186	32.362	32.001	135.051	219.494	438.855	47.013
12217.5469	1500.1609	10299.0358	0.52031017	32.284	31.911	134.015	218.306	437.222	46.733

CASE 6

RPM 180

CG .5"

PROV 2%

TIP OFF 1/4°

SUMMARY

RA	RP	A	E	I	THETA A	PHI A	TA	PERIOD	TN
12173.2719	1500.9027	10277.2690	0.51922204	32.302	32.004	135.414	217.980	435.837	46.324
12004.8668	1500.2491	10192.7399	0.51529903	32.278	31.906	134.785	214.907	430.471	46.634
12003.7813	1500.7213	10192.4332	0.51523811	32.214	31.978	135.564	215.130	430.451	45.432
12166.5833	1500.2109	10273.5790	0.51911668	32.413	31.865	134.060	217.447	435.602	48.227
12239.8994	1499.4779	10309.8705	0.52088053	32.246	31.855	133.120	218.409	437.912	46.674
11709.6904	1500.5776	10045.3159	0.50815291	32.270	32.116	139.034	211.178	421.165	44.981
12254.2930	1499.2904	10316.9735	0.52122857	32.247	31.844	132.915	218.591	438.365	46.750
12378.1223	1499.8301	10379.1581	0.52404503	32.396	32.203	137.441	222.079	442.334	45.990
11825.1162	1501.0093	10103.2446	0.51093027	32.315	32.034	137.215	212.594	424.814	46.159
11915.6000	1500.9324	10148.4480	0.51311627	32.354	32.070	137.371	214.176	427.668	46.370
12384.7402	1499.9222	10382.5131	0.52418996	32.316	31.871	133.005	220.868	442.549	47.369
12419.8427	1500.8957	10400.5510	0.52492157	32.236	32.084	135.695	222.293	443.702	44.984
11964.2000	1500.1743	10172.3689	0.51433574	32.373	31.885	134.977	214.270	429.181	47.677
12096.9927	1500.9186	10239.1376	0.51743001	32.251	32.042	136.233	216.924	433.413	45.437
12600.9724	1500.9427	10491.1394	0.52901927	32.283	32.047	134.313	225.002	449.512	45.944
12126.3511	1500.3459	10253.5304	0.51816325	32.339	31.910	134.516	216.899	434.328	47.277
12260.9900	1500.8287	10321.0912	0.52127054	32.394	32.104	136.409	219.779	438.627	46.664
12780.9374	1500.9275	10581.1143	0.53302562	32.353	32.087	134.145	228.065	455.307	46.504
12559.0214	1500.4757	10469.9304	0.52810980	32.354	32.143	135.871	224.734	448.150	46.032
12404.1849	1500.2429	10392.3958	0.52461157	32.244	31.916	133.194	221.264	443.181	46.336
12230.5103	1501.0659	10305.9700	0.52054511	32.270	32.057	135.933	219.118	437.664	45.605
12078.3053	1500.9398	10229.8044	0.51698768	32.346	31.994	135.716	216.449	432.821	46.831
12317.2836	1499.9247	10348.7859	0.52263903	32.312	31.880	133.347	219.811	440.394	47.251
12212.4940	1498.5283	10295.6930	0.52031299	32.300	32.225	139.286	219.767	437.009	44.424
11692.9888	1499.2512	10036.3019	0.50784332	32.209	31.852	135.041	209.674	420.599	46.078
12817.2147	1499.3239	10598.4512	0.53394080	32.336	31.811	130.682	227.633	456.427	48.055
11961.1722	1500.9305	10171.2333	0.51420716	32.353	32.064	137.077	214.862	429.109	46.413
11776.5923	1500.8506	10078.9033	0.50976487	32.327	32.047	137.588	211.882	423.279	46.178
6985.4022	1501.0012	7683.3835	0.35690012	32.358	32.012	154.887	140.962	281.732	44.535
12495.8269	1500.6113	10438.4010	0.52667146	32.217	32.111	136.014	223.689	446.127	44.473
12268.0490	1500.7424	10324.5776	0.52144054	32.223	32.078	136.212	219.838	438.850	44.822
12006.9740	1500.9615	10194.1495	0.51529618	32.256	32.030	136.422	215.445	430.560	45.569
12155.4858	1500.8763	10268.3629	0.51880761	32.288	32.048	136.123	217.889	435.270	45.861
11922.7814	1500.8244	10151.9847	0.51329653	32.283	32.109	138.013	214.487	427.892	45.253
12205.1959	1500.6112	10293.0853	0.51998912	32.231	31.962	134.554	218.265	436.843	45.813
12204.2750	1500.9665	10292.8027	0.51994141	32.378	32.006	135.369	218.498	436.825	47.119
11956.3364	1500.6726	10168.6863	0.51411085	32.318	31.958	135.712	214.367	428.948	46.717
12288.3280	1500.8516	10334.7716	0.52190202	32.421	31.971	134.688	219.732	439.500	47.769
12090.4211	1500.8863	10235.8356	0.51727750	32.290	31.994	135.599	216.620	433.204	46.229
11999.3416	1500.3285	10190.0170	0.51516172	32.402	31.901	135.059	214.896	430.298	47.867

CASE 7

RPM 180

CG .5"

PROD 3%

TIP OFF 1/4"

SUMMARY

RA	KP	A	E	I	THETA A	PHI A	TP	PERIOD	TN
12355.9904	1500.8445	10368.6013	0.52346221	32.265	32.087	135.961	221.273	441.659	45.340
11774.9193	1501.1476	10076.1652	0.50969950	32.256	31.996	136.849	211.635	423.233	45.744
12320.1382	1500.5177	10350.5098	0.52266124	32.256	32.122	136.757	220.889	440.504	44.926
11865.4711	1500.8793	10123.3571	0.51191476	32.346	32.065	137.503	213.364	426.083	46.297
12185.1635	1500.9853	10283.2562	0.51949392	32.257	32.029	135.673	218.263	436.218	45.632
12212.8503	1501.0969	10297.1554	0.52013168	32.288	32.064	136.109	218.869	437.102	45.765
12154.9337	1500.7787	10268.2381	0.51880189	32.328	32.061	136.276	217.923	435.250	46.210
12049.7556	1501.0501	10215.5847	0.51630454	32.241	32.036	136.322	216.146	431.919	45.346
12361.6091	1500.9978	10371.4854	0.52358034	32.299	32.035	135.081	221.110	441.844	46.142
12306.6049	1500.9761	10343.4723	0.52233082	32.315	31.958	134.325	219.923	440.055	46.812
12228.5737	1500.9948	10304.9661	0.52050529	32.332	32.001	135.176	218.858	437.600	46.697
12319.2739	1500.5064	10350.6720	0.52264214	32.355	31.914	133.807	219.993	440.476	47.472
12394.7450	1500.4144	10387.7616	0.52438298	32.384	31.920	133.636	221.237	442.884	47.735
12185.0848	1500.6708	10283.0596	0.51951532	32.366	31.965	134.936	218.036	436.205	47.231
13007.6746	1500.9147	10694.4764	0.53797677	32.304	32.052	132.707	231.580	462.644	46.261
11950.3699	1500.7630	10165.7483	0.51396152	32.266	31.962	135.680	214.256	428.762	46.130
12479.6250	1500.8686	10430.4287	0.52628502	32.295	32.064	135.048	223.126	445.616	45.920
11767.4819	1500.5721	10074.2089	0.50956408	32.317	32.123	138.796	212.085	422.984	45.509
12639.3334	1500.4728	10510.0854	0.52991290	32.321	31.921	132.519	225.121	450.730	47.204
12634.6364	1500.4993	10507.7498	0.52980597	32.325	31.912	132.477	225.028	450.580	47.311
12725.0173	1500.8783	10553.1299	0.53179198	32.266	32.004	133.153	226.801	453.502	46.100
11885.5161	1500.7181	10133.2990	0.51240954	32.276	31.968	136.025	213.257	426.711	46.176
12391.1021	1500.7990	10386.1324	0.52427134	32.252	32.008	134.577	221.463	442.780	45.814
12666.9479	1499.9344	10523.6230	0.53056888	32.271	32.154	136.004	226.628	451.601	44.873
12451.2139	1500.9034	10416.2405	0.52563641	32.273	32.018	134.477	222.469	444.707	45.993
12723.5100	1500.9342	10552.4039	0.53175446	32.291	32.045	133.803	226.968	453.455	46.101
11815.4294	1500.9173	10099.6552	0.51077525	32.310	32.009	136.882	212.379	424.600	46.257
12532.7043	1500.8208	10456.9445	0.52749079	32.296	32.084	135.153	224.071	447.316	45.785
12183.4283	1500.9622	10282.3771	0.51945509	32.277	32.065	136.277	218.414	436.162	45.627
12306.4518	1500.8415	10343.8285	0.52232161	32.319	32.100	136.275	220.516	440.078	45.882
12792.5590	1500.5520	10586.7374	0.53330912	32.292	31.950	132.159	227.669	455.670	46.760
12684.1499	1500.8548	10532.6842	0.53089534	32.294	32.098	134.765	226.572	452.185	45.705
11930.7777	1500.7713	10155.9563	0.51349209	32.265	32.000	136.277	214.103	428.143	45.857
12306.8616	1501.0905	10344.1578	0.52231275	32.280	32.022	135.106	220.179	440.099	46.007
12637.4953	1500.9817	10509.4203	0.52983482	32.299	32.029	133.922	225.516	450.687	46.273
11843.8317	1500.9959	10112.5957	0.51138384	32.306	32.025	137.021	212.853	425.404	46.124
12432.6861	1500.7521	10407.0009	0.52522980	32.328	31.995	134.275	222.093	444.115	46.744
12843.1322	1500.8376	10612.1667	0.53440052	32.215	32.074	133.857	229.057	457.313	44.911
12420.4906	1500.9622	10400.9082	0.52493149	32.316	32.079	135.502	222.246	443.725	46.040
12395.3864	1500.4285	10389.5892	0.52446529	32.273	31.909	133.207	221.171	443.001	46.694

CASE 8

RPM 180

CG .5"

PROD 1%

TIP OFF ½°

SUMMARY

RA	RP	A	E	I	THETA A	PHI A	TA	PERIOD	TN
12547.6088	1500.6495	10464.3109	0.52783979	32.325	32.115	135.542	224.441	447.789	45.899
12556.0427	1501.1549	10468.7806	0.52799310	32.323	32.003	133.906	224.108	448.076	46.694
12260.0233	1500.4605	10320.4238	0.52127524	32.301	32.140	137.207	219.993	438.585	45.321
12847.1786	1500.9436	10614.2429	0.53448160	32.275	31.982	132.363	228.684	457.447	46.384
12646.0984	1500.8195	10513.6407	0.53003898	32.346	31.959	133.008	225.389	450.959	47.240
12276.8225	1500.9665	10329.0764	0.52162728	32.294	32.057	135.732	219.850	439.136	45.892
12079.9192	1501.1039	10230.6934	0.51701361	32.339	32.028	136.101	216.595	432.877	46.536
12117.9232	1500.7624	10249.5247	0.51793431	32.277	31.956	134.969	216.899	434.073	46.356
12228.8900	1500.9053	10305.0796	0.52051926	32.306	32.040	135.693	219.016	437.607	46.147
12311.5497	1500.9994	10346.4564	0.52242768	32.306	32.078	135.895	220.494	440.245	45.883
12786.0513	1500.5638	10583.4894	0.53316478	32.255	31.958	132.313	227.602	455.460	46.322
12338.0295	1500.7883	10359.5908	0.52305355	32.295	32.065	135.625	220.864	441.084	45.875
12010.9564	1500.8747	10196.0974	0.51539728	32.234	32.088	137.455	215.822	430.683	44.834
11771.0005	1500.8598	10076.1121	0.50962816	32.382	32.034	137.417	211.736	423.104	46.822
11903.3529	1500.6042	10142.1604	0.51284679	32.289	32.030	136.874	213.812	427.271	45.929
11979.4805	1499.6375	10179.7408	0.51474017	32.346	31.920	134.132	214.267	429.648	47.769
11518.2163	1500.9165	9949.7483	0.50339464	32.319	32.035	138.402	207.766	415.169	46.083
12248.3176	1500.7317	10314.7065	0.52098361	32.161	31.951	134.131	218.878	438.220	45.293
12538.9302	1500.7882	10460.0410	0.52763379	32.261	32.065	134.868	224.093	447.515	45.521
12006.4346	1500.6951	10193.7467	0.51530315	32.356	32.098	137.382	215.720	430.535	46.224
12749.2113	1500.6896	10565.1323	0.53234174	32.295	32.008	133.203	227.231	454.276	46.422
12386.2994	1501.1714	10383.9172	0.52413400	32.290	32.025	134.876	221.476	442.638	46.131
12556.3196	1500.9686	10468.8259	0.52801293	32.303	32.042	134.426	224.266	448.079	46.197
12319.5892	1500.2866	10350.1198	0.52266558	32.353	32.133	136.688	220.856	440.479	46.033
12699.0154	1500.5440	10539.9615	0.53123872	32.248	31.949	132.481	226.144	452.653	46.263
12528.8505	1500.6366	10454.9254	0.52741715	32.324	31.986	133.771	223.590	447.186	46.801
12229.3087	1500.9326	10305.3025	0.52052699	32.325	31.965	134.692	218.724	437.621	46.840
11507.2162	1500.6092	9944.0945	0.50314320	32.303	31.977	137.693	207.361	414.816	46.289
12853.5405	1500.9876	10617.4459	0.53461789	32.278	32.055	133.467	229.125	457.654	45.907
12216.6527	1500.5026	10298.7595	0.52026413	32.320	31.967	134.794	218.530	437.205	46.779
11756.6993	1500.0142	10068.5387	0.50936330	32.300	32.142	139.247	212.028	422.627	45.149
12434.2959	1500.6354	10407.6475	0.52527051	32.295	31.998	134.287	222.116	444.157	46.379
12059.5718	1501.0035	10220.4696	0.51654028	32.382	31.991	135.773	216.148	432.229	47.186
12117.4424	1500.8507	10249.3285	0.51791646	32.295	31.982	135.360	217.009	434.061	46.386
12574.6676	1500.6590	10477.8451	0.52844877	32.303	31.993	133.654	224.346	448.658	46.545
12351.1884	1500.3374	10365.9447	0.52338939	32.267	31.903	133.317	220.392	441.490	46.650
12251.2073	1500.2010	10315.8860	0.52108982	32.281	31.902	133.749	218.804	438.296	46.772
12085.2893	1500.5391	10233.0958	0.51718220	32.340	32.101	137.116	216.981	433.030	46.036
12536.9186	1500.8735	10459.0779	0.52758212	32.305	32.027	134.276	223.883	447.453	46.321
12048.5348	1499.7832	10214.3408	0.51636967	32.290	32.172	138.763	216.834	431.840	44.826

CASE 9

RPM 180

CG .5"

PROD 1%

TIP OFF 3/4°

SUMMARY

RA	RP	A	E	I	THETA A	PHI A	TA	PERIOD	TN
11975.9397	1499.3810	10177.8423	0.51467485	32.283	31.825	134.004	214.165	429.527	47.148
12332.0956	1500.5992	10356.5293	0.52293081	32.404	31.944	134.180	220.326	440.888	47.767
12300.7849	1501.0294	10341.0891	0.52217690	32.285	32.035	135.286	220.128	439.903	45.960
11985.7993	1499.5845	10172.8738	0.51441781	32.314	32.183	139.135	215.533	429.213	45.018
12358.2367	1498.4177	10368.5092	0.52369241	32.252	31.778	131.808	220.028	441.654	47.215
12108.0005	1501.1152	10244.7396	0.51767471	32.198	32.052	136.317	217.140	433.769	44.641
12626.6769	1500.3506	10503.6956	0.52963866	32.299	32.132	135.545	225.803	450.319	45.446
12493.7682	1500.9989	10437.5654	0.52659643	32.381	32.073	135.078	223.382	446.073	46.816
12667.5924	1501.0225	10524.4894	0.53050412	32.275	32.061	134.262	226.139	451.657	45.763
12148.9316	1500.8832	10265.0892	0.51865348	32.370	32.128	137.263	218.118	435.062	46.215
11679.4652	1500.5053	10030.1671	0.50741726	32.241	32.132	139.611	210.840	420.213	44.421
10939.7241	1500.2459	9660.1669	0.48857740	32.289	31.918	139.147	198.311	397.177	46.279
11346.0105	1500.7888	9863.5815	0.49906931	32.190	32.038	139.032	205.062	409.788	44.415
10152.0443	1499.5272	9265.9677	0.46689766	32.304	32.197	146.517	187.603	373.116	44.237
12182.9675	1500.8012	10282.0662	0.51945622	32.337	31.979	135.112	218.054	436.142	46.870
11929.3951	1499.9823	10154.8705	0.51351777	32.250	31.887	134.780	213.617	428.074	46.428
11855.8530	1499.2466	10117.7317	0.51180476	32.175	31.867	134.408	212.244	425.728	45.638
12047.8070	1500.6234	10214.3971	0.51629008	32.260	31.990	135.702	215.921	431.843	45.917
12558.2914	1499.4227	10469.0389	0.52817021	32.280	31.827	131.748	223.472	448.092	47.344
12755.9630	1501.1469	10568.7368	0.53245796	32.309	32.023	133.329	227.393	454.508	46.468
11426.6398	1500.7957	9903.8995	0.50110788	32.251	32.099	139.834	206.656	412.303	44.783
11711.4679	1500.2914	10046.0615	0.50821790	32.243	31.925	136.109	210.326	421.212	46.039
12176.6444	1499.2915	10278.1498	0.51941999	32.259	31.836	133.147	217.332	435.893	46.882
12208.5077	1499.7416	10294.3065	0.52013053	32.263	31.882	133.622	218.026	436.921	46.677
12484.4761	1500.7551	10432.7975	0.52640345	32.234	32.053	134.882	223.160	445.768	45.251
11832.9226	1500.5791	10106.9326	0.51115130	32.249	32.106	138.432	213.084	425.046	44.809
11993.2712	1500.1329	10186.8840	0.51503181	32.208	31.933	134.869	214.733	430.100	45.640
12379.4871	1501.1272	10380.4890	0.52398109	32.307	32.002	134.559	221.264	442.419	46.465
11465.1704	1498.3727	9921.9534	0.50225986	32.362	32.247	142.104	207.943	413.431	44.923
12095.3890	1500.7150	10238.2339	0.51740731	32.250	32.097	137.266	217.201	433.356	44.990
12204.2992	1500.5667	10292.6149	0.51997150	32.373	32.115	136.801	218.921	436.813	46.334
3589.1494	1500.1130	5984.8130	0.17452812	32.413	32.241	169.166	98.036	193.679	41.827
12024.1990	1500.6348	10202.5988	0.51572959	32.239	31.959	135.317	215.402	431.095	45.880
11052.8733	1498.1592	9715.6981	0.49171527	32.428	32.292	144.096	201.651	400.607	45.221
11633.4512	1500.6916	10007.2533	0.50627077	32.243	31.979	137.131	209.321	418.774	45.664
12024.5018	1499.1348	10202.0001	0.51584821	32.319	31.822	133.928	214.964	431.058	47.534
11853.0389	1499.5821	10116.4924	0.51171180	32.377	32.206	139.661	213.778	425.650	45.580
11080.1411	1500.8351	9730.6699	0.49222233	32.250	31.977	139.257	200.689	401.533	45.553
12470.8157	1500.6038	10425.8916	0.52610426	32.266	32.101	135.752	223.181	445.325	45.254
11434.9033	1499.9383	9907.6027	0.50138088	32.340	32.186	141.191	207.187	412.534	45.199

CASE 10
RPM 180
CG 1.5"
PROD 1%
TIP OFF 3/4°

SUMMARY

RA	RP	A	E	I	THETA A	PHI A	TA	PERIOD	TN
12116.2188	1491.0403	10243.8114	0.51861452	32.337	31.623	131.936	215.980	433.710	48.885
11939.4368	1500.5414	10160.1710	0.51371653	32.315	32.132	138.294	215.035	428.409	45.658
11903.3898	1499.0880	10141.4208	0.51296076	32.435	31.953	136.684	213.914	427.224	48.200
12568.3020	1500.8018	10474.7338	0.52829506	32.246	32.114	135.186	224.884	448.458	44.930
12260.8423	1499.9772	10320.5917	0.52132986	32.262	32.229	139.558	220.884	438.595	43.802
12266.5925	1496.8968	10321.9265	0.52169020	32.299	31.911	133.864	219.233	438.681	47.051
12027.3527	1500.1537	10203.9351	0.51584017	32.403	32.079	137.554	216.301	431.180	47.189
12007.6957	1500.6253	10194.3423	0.51533832	32.223	32.186	139.223	216.474	430.572	43.459
11999.2120	1500.7264	10190.1511	0.51512905	32.386	32.167	138.814	216.209	430.307	46.357
12284.8529	1499.4653	10332.3408	0.52192372	32.351	32.296	140.496	221.567	439.345	44.670
11811.1055	1500.9904	10096.2297	0.51059234	32.257	32.150	138.945	213.058	424.371	44.561
12231.9224	1498.5382	10305.4122	0.52076443	32.308	31.961	134.636	218.897	437.628	46.852
11854.9658	1488.5445	10111.9370	0.51258337	32.395	31.449	132.158	211.548	425.362	50.101
11846.9034	1491.0192	10109.1432	0.51220386	32.235	31.747	132.821	211.662	425.186	46.917
12160.5538	1495.4540	10268.1857	0.51932737	32.250	31.903	133.470	217.276	435.259	46.359
12727.7959	1501.0840	10554.6218	0.53183867	32.269	32.171	135.817	227.832	453.598	44.790
12426.8771	1500.4639	10403.8523	0.52511382	32.415	32.132	136.608	222.865	443.914	47.069
12468.3976	1500.9924	10424.8770	0.52602085	32.265	32.160	136.421	223.533	445.260	44.717
12415.9243	1500.4236	10398.3558	0.52486667	32.263	32.219	138.366	223.198	443.562	43.989
12122.8058	1493.8010	10248.4852	0.51856468	32.348	31.729	132.995	216.456	434.007	48.515
11920.9961	1495.9111	10148.6355	0.51362004	32.392	31.784	134.564	213.521	427.680	48.593
12739.0565	1500.0558	10559.7380	0.53216286	32.318	32.041	133.735	227.391	453.928	46.622
12175.4966	1498.3722	10277.1162	0.51946112	32.276	31.995	135.117	218.072	435.827	46.217
12310.1044	1500.9409	10345.7045	0.52239863	32.242	32.196	138.275	221.364	440.197	43.859
12149.0786	1499.3573	10264.3999	0.51876981	32.205	32.203	141.109	219.427	435.018	41.854
12308.6335	1501.1781	10345.0876	0.52234721	32.301	32.178	137.647	221.157	440.158	45.160
12037.4709	1500.7997	10209.3171	0.51603213	32.288	32.168	138.454	216.755	431.521	44.940
12422.9982	1500.7446	10402.0532	0.52500470	32.343	32.174	137.242	222.992	443.799	45.868
11902.4091	1496.2778	10179.5253	0.51505993	32.270	31.889	134.477	214.550	429.634	46.724
11963.6824	1500.1322	10172.0891	0.51432651	32.343	32.279	141.398	216.367	429.163	44.701
12378.2311	1500.8410	10379.7179	0.52397331	32.337	32.239	138.656	222.645	442.370	45.119
12076.9810	1500.8483	10229.0964	0.51696320	32.285	32.206	139.331	217.691	432.776	44.549
11929.9219	1495.4927	10152.8892	0.51386502	32.317	31.850	134.584	213.674	427.949	47.444
12149.5066	1501.3859	10265.6282	0.51862977	32.250	32.156	137.794	218.480	435.096	44.485
12243.3638	1501.3509	10312.5392	0.52082289	32.412	32.121	137.177	219.901	438.082	47.060
12389.9338	1500.5151	10385.4063	0.52426542	32.285	32.157	136.918	222.322	442.734	45.117
12040.6982	1500.2965	10210.6792	0.51614596	32.331	32.096	137.397	216.486	431.608	46.199
12372.1410	1500.5839	10376.5443	0.52385249	32.255	32.223	138.852	222.593	442.167	43.712
12149.0865	1499.4956	10264.4729	0.51875976	32.239	32.078	136.013	217.908	435.023	44.984
12401.4907	1492.1367	10386.9956	0.52514483	32.320	31.674	131.071	220.629	442.835	48.590

ONE MINUTE COAST

SUMMARY

RA	RP	A	E	I	THETA A	PHI A	TA	PERIOD	TN
7520.0911	3997.3837	9198.9192	0.19147398	37.327	33.782	135.059	188.408	369.073	98.485
7619.0751	4000.8947	9250.1667	0.19557380	37.458	33.087	132.400	188.353	372.162	100.247
7412.1778	4001.8554	9147.1985	0.18641348	37.061	31.440	128.602	181.935	365.965	100.894
7416.2993	4002.1219	9149.3925	0.18657946	37.391	32.582	131.702	184.280	366.097	100.240
7397.1805	3999.5548	9138.5496	0.18589523	37.425	33.424	134.290	185.749	365.446	99.037
7286.2356	3997.7074	9082.1533	0.18104342	37.559	30.108	126.062	177.669	362.068	103.450
7537.2298	3998.6638	9208.1287	0.19214360	37.337	33.571	134.284	188.192	369.628	98.905
7639.9875	4002.4822	9261.4167	0.19637953	37.330	31.881	128.933	186.254	372.841	101.766
7441.0994	4002.4596	9161.9614	0.18765850	37.109	31.817	129.497	183.120	366.851	100.607
7572.1680	4000.1728	9226.3523	0.19357570	37.277	33.247	133.144	188.032	370.725	99.337
7226.6162	4001.3462	9054.1631	0.17810978	37.332	31.153	128.634	178.642	360.396	101.379
7224.6007	4002.5129	9053.7386	0.17794239	37.310	31.933	130.638	180.118	360.370	100.323
7524.8033	4002.3803	9203.7737	0.19135755	37.597	32.396	130.750	185.524	369.365	101.403
7458.0192	4002.5182	9170.4506	0.18840411	37.815	32.175	130.402	184.085	367.361	102.093
7670.3474	4000.9709	9275.8411	0.19779212	37.301	33.038	132.112	189.057	373.712	100.002
7305.6301	4002.4409	9094.2173	0.18160932	37.596	32.263	131.214	181.974	362.790	100.908
7437.7657	4002.0784	9160.1039	0.18753539	37.125	31.548	128.799	182.541	366.740	101.011
7560.3463	4002.4718	9221.5909	0.19291002	37.597	31.990	129.534	185.270	370.438	102.093
7185.5659	4002.1164	9034.0229	0.17619225	37.167	32.659	132.827	181.021	359.194	98.839
7617.4713	4002.2207	9250.0278	0.19541836	37.376	32.513	130.750	187.166	372.153	100.890
7356.0182	4002.1003	9119.2412	0.18389238	37.347	32.615	132.028	183.451	364.288	99.898
7461.4918	4002.1057	9171.9806	0.18858446	37.109	31.568	128.758	182.933	367.453	101.014
7325.0719	4000.2584	9102.8470	0.18262493	37.395	30.767	127.351	179.405	363.306	102.372
7397.8557	4001.9816	9140.1005	0.18576787	37.330	31.465	128.770	181.801	365.539	101.556
7337.4671	4002.4943	9110.1626	0.18303586	37.111	32.023	130.450	181.979	363.745	100.003
7475.3371	4001.3696	9178.5353	0.18924411	37.430	31.193	127.820	182.463	367.847	102.450
7236.0299	4002.5063	9059.4500	0.17846137	37.191	31.913	130.532	180.243	360.712	100.060
7754.0181	4002.3680	9318.3749	0.20130388	37.295	32.430	130.010	189.068	376.286	101.179
7623.9787	4002.4147	9253.3785	0.19568874	37.309	31.844	128.895	185.937	372.355	101.705
7565.8072	4002.1119	9224.1415	0.19317219	37.584	32.614	131.198	186.571	370.592	101.173
7505.1956	4002.5496	9194.0544	0.19048430	37.190	32.163	130.206	184.780	368.780	100.541
7695.7809	4002.5132	9289.3289	0.19879088	37.219	32.186	129.549	187.697	374.528	101.164
7315.0217	4002.2010	9098.7933	0.18204726	37.394	32.533	131.944	182.666	363.064	100.022
7144.0063	4001.1303	9012.7502	0.17435721	37.206	33.019	134.061	181.162	357.926	98.332
7605.0400	4002.4421	9243.9230	0.19486304	37.389	31.882	129.071	185.729	371.785	101.815
7509.0187	4002.1855	9195.7839	0.19067614	37.292	31.682	128.904	183.888	368.884	101.521
7617.5244	4001.2001	9249.5441	0.19548663	37.274	32.982	132.151	188.149	372.124	99.871
7605.1393	4002.2085	9243.8558	0.19488246	37.558	31.628	128.431	185.253	371.781	102.641
7385.3535	3994.6847	9130.2010	0.18568423	37.454	34.195	136.896	187.277	364.945	97.866
7472.8840	4002.3575	9177.8026	0.18907175	37.184	31.813	129.373	183.594	367.803	100.924